STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF UNDERGROUND STORAGE TANKS

TECHNICAL CHAPTER 3.5
PRESSURIZED PIPING AND LINE TIGHTNESS TESTING

EFFECTIVE DATE – TBD

PURPOSE

The purpose of this technical chapter is to assist Division of Underground Storage Tanks (Division) staff in understanding the regulatory requirements for the installation, operation, release detection, and recordkeeping requirements for Underground Storage Tank (UST) systems which convey petroleum with pressurized piping.

This technical chapter contains the current policy of the Division based on the statute and regulations governing the Tennessee Petroleum Underground Storage Tank program. This document supersedes all previously published versions. The most current version of this technical chapter will be posted and always available on the Division's website.

AUTHORITY

All rules referred to in this technical chapter are contained in Chapter 0400-18-01 and are available on the Division of Underground Storage Tanks website at http://www.tn.gov/sos/rules/0400/0400-18/0400-18-01.20120307.pdf

APPLICABILITY

This document provides technical and specific industry knowledge regarding the installation, inspection, operating, and release detection requirements for pressurized piping UST systems. The document also provides specific information related to automatic line leak detection, line tightness testing, and monthly monitoring requirements for pressurized piping.

INTRODUCTION

Pressurized piping has become an integral part of the petroleum industry. Petroleum conveyed under pressure from the underground storage tank to the dispenser by use of a submersible turbine pump allows fuel to be dispensed faster. Although this is a very advantageous aspect of pressurized piping, there are some disadvantages which are discussed in detail in this document.

Red Jacket Submersible Turbine Pump

Mechanical Line Leak Detectors
Red Jacket, FE Petro, and Vaporless

In a pressurized piping system, a submersible turbine pump (STP) moves stored product from the tank to the dispenser. The delivery piping extends from the pump discharge point to the dispenser. The product is essentially "pushed" from the tank under positive pressure. The advantage of pressurized piping is a single product line can be used for multiple dispensers and reduces the quantity of buried piping. Submersible pumps are in use at most larger UST systems installed since the early 1980s.

Piping and associated loose fittings cause the majority of petroleum releases from UST systems. Catastrophic releases can occur very quickly if a hole or break occurs in a pressurized pipeline, or if components of the STP are installed improperly because the pump will continue to push product through the line as well as any hole or break, if present. Additionally, higher line pressures will result in higher leak rates when a hole develops.

DEFINITIONS

Bulk modulus "elasticity"- The ratio of hydrostatic pressure to the relative change it produces in volume of a liquid. This is used for programming electronic line leak detectors when installed with various types of flexible plastic piping.

Calculated leak rate- the calculated equivalent rate of loss (or gain) expressed in gallons per hour (gph) of allowed by an automatic line leak detector relative to the amount of line pressure in which the device is installed. Any MLLD which allows a higher calculated leak rate than 3.0 gallons per hour at 10 psi must be replaced because it does not meet the standard in rule .04(4)(a).

Full Pump Pressure- the maximum amount of pressure (psi) found during full flow output from the submersible pump while not dispensing fuel. This varies according to the submersible pump output capacity, piping length, number of dispensers, and other site specific factors. (Typically around 25 psi range but is variable.)

Holding Pressure- the amount of pressure in pounds per square inch (psi) found in a product line when the STP is turned off. The functional element or internal STP check valve holds pressure in the line during idle time. This is also known as static line pressure. This reading is used to determine that the functional element or STP check valve is functioning properly.

Leak Rate Test- the rate in gallons per hour (gph) allowed during a leak detector test. This number varies depending on the metering pressure of the leak detector. If a leak detector tests at a metering pressure of 10 psi, the leak rate that occurs with a 3.0 gph leak would be exactly 3.0 gph. If the metering pressure is 15 psi the leak rate would be 3.7 gph. The metering pressure determines the leak rate at which the leak detector during a test. A conversion table (Table 2) is located in Appendix B which converts the leak rate from milliliters per minute (ml/min) to gallons per hour (gph).

Metering Pressure- the amount of pressure (psi) at which a leak detector operates when searching for a leak. This pressure is typically ten (10) to fifteen (15) psi but can vary. This reading confirms that the leak detector is entering leak test mode and is used to determine the actual leak test rate while the device is operating.

Opening Time- the length of time needed for the STP to reach full operating pressure. This must not exceed the amount of time needed for the LLD to detect a leak while a leak is being simulated. This amount of time is typically two (2) to four (4) seconds but can be longer if the piping has air pockets or high elasticity due to long runs of flexible plastic piping or multiple flex connectors.

Resiliency or bleed back- total amount of fuel (measured in gallons) collected in the volumetric cylinder of the testing device when the STP operating pressure is reduced to zero. This is used to determine the amount of allowable loss of pressure during the test from large diameter piping, flex connectors, or flexible plastic piping. Bleed back readings are typically low (50-100 ml) for rigid piping and high (300-500 ml) for longer flexible piping systems. Higher bleed back readings may indicate the presence of air pockets in some systems.

Unmanned Facility- means either an unattended emergency generator or a facility that dispenses fuel without the presence of an attendant that monitors the pumps, such as card lock fleet facilities or an unattended service station.

INSTALLATION AND REPAIR REQUIREMENTS FOR PRESSURIZED PIPING

1) Installation Certification

Some petroleum underground storage tank systems have complex piping delivery systems which can be a source of petroleum releases into the environment when installed and/or maintained improperly. UST system installations must be certified, as required by rule .03(1)(d)1. and .03(2)(a)1., when the UST system is registered by one of the following methods:

a. Piping Manufacturer Certified Installer
b. Installation Certification by a registered professional engineer
c. Installation inspected/approved by Division personnel
d. Piping manufacturer' installation checklists are completed

The certification method must be indicated within 30 days of completion of installation using the Division's Notification Form as required by rule .03(1)(a)2. for the newly installed system and within 30 days of completion for any subsequent change in status as required by rule .03(1)(g). Although the Division currently does not conduct UST installation inspections, as allowed under rule .03(1)(d)1.(iii), installers are encouraged to contact the local Division field office and notify them of construction activities before beginning work. The Pre-installation Notification Form must be submitted fifteen (15) days prior to installation as required by rules .03(1)(a)1. and .02(1)(a). Division personnel may choose to observe the installation process and document the installation with photographs for future reference.

Please be advised, manufacturers may also require specific training before piping is installed at a UST facility. If training is required, it must be demonstrated to the Division, as required by rule .02(1)(a) and (b), that the installer completed the required course and their training is still current.

2) Piping Construction Standards

All piping installed after November 1, 2005 must meet Standard for Safety in Underwriters Laboratory UL 971- "Non-Metallic Underground Piping for Flammable Liquids". The piping shall be marked by the manufacturer and contain manufacturer and product model information. While all known piping manufacturers currently comply with this standard for new piping, the tank owner/operator (O/O) should have documentation to verify this information. An installer's statement, manufacturer's checklist or installation photos will satisfy these requirements, see rule .02(4)(b)1, and .02(1)(b).

3) UST Systems Installed/Replaced On or After July 24, 2007

Rule .02(2)(b) requires that all new UST piping installations/replacements on or after July 24, 2007 have double-walled piping and secondary containment (tank and dispenser sumps), and conduct interstitial monitoring as the primary method of leak detection continuous monitoring of sumps using electronic sensors, see rules .02(1)(c), .02(6) and .04(3)(g)1.

Catastrophic line leak detection is also required on these systems by rule .04(2)(b)1.(i) and .04(4)(a). Owners/operators can choose any additional release detection methods for piping systems such as line tightness testing, but interstitial monitoring **must** be conducted on all new piping installations. Refer to **Technical Chapter 3.4** for interstitial monitoring requirements.

Fuel dispensers that are replaced in which the piping is reconfigured below the shear valve must also meet secondary containment requirements as required by rule .02(6)(e).

4) **Piping Repairs**

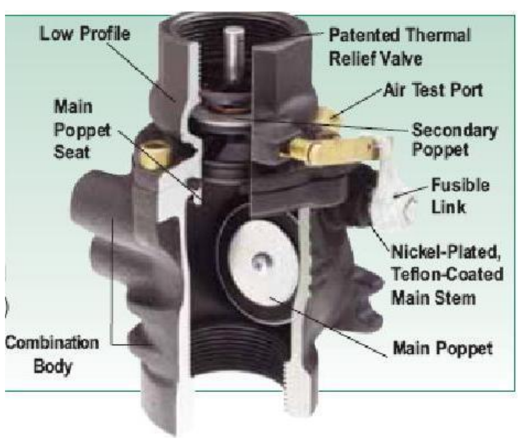
The Division may, under rule .02(6)(c) and (d), allow a piping repair which is not considered a replacement. Requests for piping repair must be submitted to the Division in writing prior to beginning the repair as required by rule .02(6)(d)2. Repairs to sections of single wall steel piping are not allowed by rule .02(7)(c). Piping repairs must be made in accordance with the manufacturer's specifications as required by rules .02(1)(b) and .02(7)(c). All repaired piping must be tightness tested within 30 days of completion as required by rule .02(7)(d).

COMMON PROBLEMS ASSOCIATED WITH PRESSURIZED PIPING INSTALLATIONS

1) **Dispenser Leaks**

If a fuel dispenser is found to be leaking, the owner/operator should immediately activate the dispenser shear valve and notify the Division within seventy-two (72) hours if they suspect petroleum has escaped into the environment as required by rule .05(1)(a).

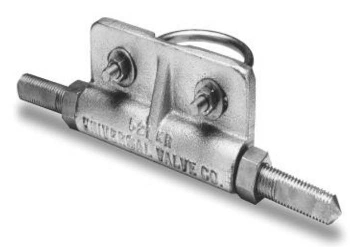
2) **Dispenser Shear Valve Anchoring**



Shear valves are components which are designed to prevent the continuous flow of product from a UST pressurized piping system in the event of a vehicle impact, fire or explosion. Shear valves are required to be installed on all pressurized piping systems by NFPA 30A. These devices are considered by the Division to be "ancillary equipment" and a regulated component of UST systems under rule .02(1)(b). These devices must be firmly secured to a fixed position such as a stabilizer bar that is permanently flush mounted in the dispenser island concrete foundation. Anchoring equipment must be designed for that purpose. Shear valve manufacturers require them to be installed within 1/2" above or below the top of the dispenser pump island. These devices should be checked for proper installation and operation by a qualified technician and on the frequency recommended by the manufacturer.

The following are examples of improperly anchored shear valves:

Another method used to anchor shear valves employs the use of “tension rod” or “extension bolt” anchoring devices. These devices consist of a U-clamp in a bracket casting combined with opposing extension bolts which, when turned, extend outward and penetrate the sump wall. These devices are required by the manufacturer to be installed such that **the points of the extension bolts always penetrate into a concrete wall**. The points must never be anchored into any other material such as metal, plastic, wood, etc. Also, the manufacturer requires that, to provide as much anchoring stability as possible, the bolts must be positioned at a 90 degree angle in relationship to the sump wall. These anchors are usually used in retro-fit situations where shear valve anchors were never originally installed or where additional stability is needed when the original anchoring system has failed.



Un-installed Extension Bolt Anchor

Properly installed into concrete

Improperly installed-not in concrete and not at 90° angle

3) **Flexible Plastic Piping Degradation**

Flexible plastic piping has become popular for installation at new UST facilities because it can be installed in a single section without sections or fittings. Some types of flexible plastic piping manufactured prior to 2005 have experienced problems with swelling and deformity of end fittings near the tank or dispenser. Microbial degradation has been found to cause piping failures in Total Containment (TCI) brand Enviroflex piping manufactured prior to 1994, referred to as 1st generation (see below).


1st generation TCI piping was recalled in 1995 and shall be replaced according to Division policy

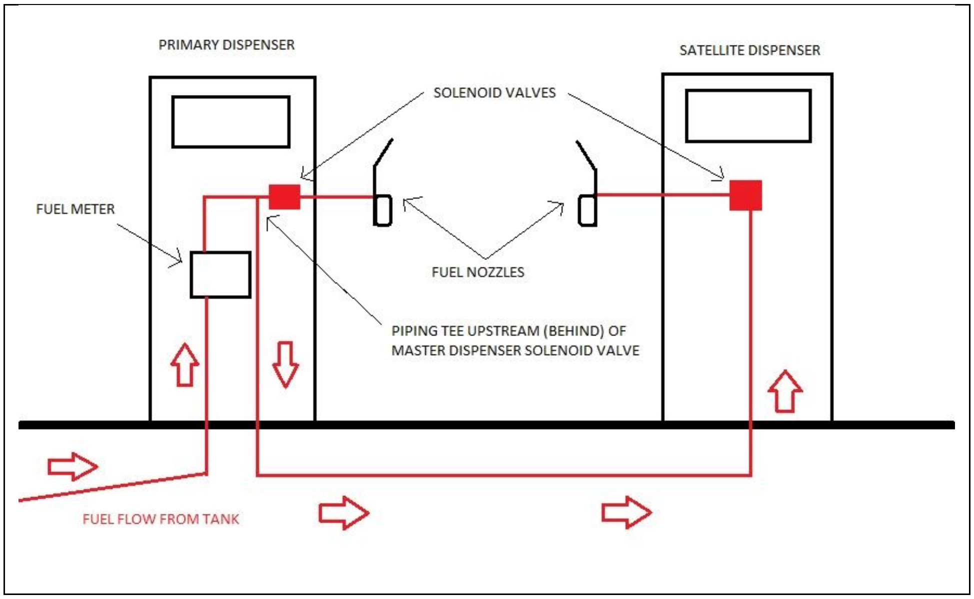
Petroleum product in contact with pipe and/or fittings in containment sumps is a potential cause of flexible plastic piping failure and should be removed immediately. It is recommended that owner/operators routinely inspect the components of flexible plastic piping and secondary containment systems for problems such as:

a. Twisting or cracks in the outer piping wall
b. Kinks or bends in flex connectors
c. Signs of swelling or bulging
d. Sump inlets or boots stretched or torn
e. Cracked metallic fitting at the terminal end of piping
f. Evidence of flaking or discoloration of the outer piping wall

4) **Satellite Dispensers**

Fleet fueling stations and truck stops commonly install satellite dispensers to dispense fuel to trucks with dual saddle tanks on each side. Product piping is usually plumbed from the master dispenser to satellite dispensers above the fuel meter and is controlled by the activation of the solenoid valve when the dispenser is activated. This allows customers to dispense fuel to both sides of a vehicle at the same time. These configurations can cause leak detection problems when configured improperly. Since satellite dispensers receive fuel by pressurized delivery, they are required to be equipped with a properly anchored shear valve.

The following diagram illustrates a properly configured satellite dispenser:



Piping from the master dispenser to the remote dispenser must be provided with leak detection and catastrophic release detection as is required by rule .04(2)(b)1. and .04(4) for the piping to the master dispenser. This can be achieved if the solenoid at the satellite dispenser is located on the outlet side of the shear valve at the satellite dispenser. The line leak detector for the master line must have the ability to monitor the satellite line. A principle being that as either dispenser is activated, the leak detector will quickly "read" the line from the point of the leak detector to the solenoid in the satellite dispenser. If the detector senses a breach anywhere in the line it will activate flow restriction.

RELEASE DETECTION

There are several types of release detection methods for pressurized piping and each method has advantages. **Rules .04(2)(b)1.(i) and .04(4)(a) require that all pressurized piping systems must be equipped with a line leak detector**. Pressurized piping must have one leak detection method from group 1) and one from group 2) below:

1) Catastrophic Line Leak Detection:
- Mechanical Line Leak Detectors (MLLD); or
- Electronic Line Leak Detectors (ELLD)

See rules .04(2)(b)1.(i) and .04(4)(a)

2) Periodic Monitoring Leak Detection:
- Continuous interstitial monitoring (required for piping installed on or after July 24, 2007);
- Annual Line Tightness Testing; or

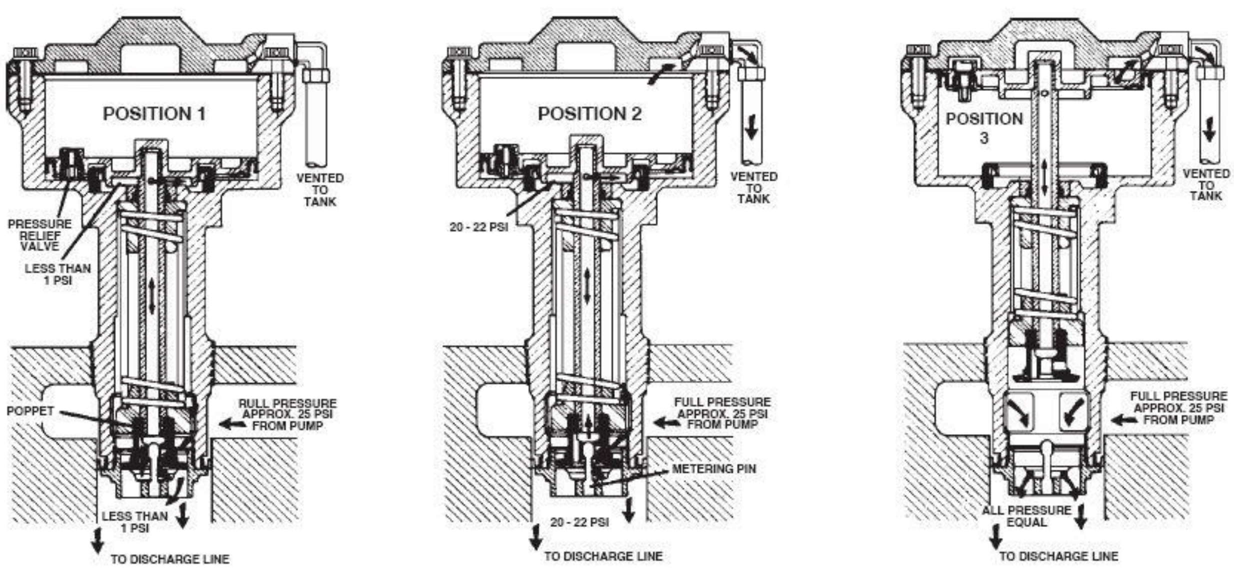
• Monthly Statistical Inventory Reconciliation (SIR); or
• Monthly test (0.2 gph) or annual test (0.1 gph) result of electronic line leak detector
See rules .04(1)(a) and .04(4)(b) and (c)

SIR and interstitial monitoring, which are two methods of monthly monitoring, have the same regulatory requirements for piping as for tanks. For more information concerning these methods of monthly monitoring see Technical Chapters 3.3 and 3.4, respectively.

REQUIREMENTS FOR MECHANICAL LINE LEAK DETECTORS:

A mechanical line leak detector (MLLD) is a pressure-sensing, piston or diaphragm-operated valve designed to detect a leak in the piping between the leak detector and the dispenser. When the submerged pump is turned on, a controlled amount of product (three gallons per hour) is metered through the MLLD into the piping system. If a leak is present which equals or exceeds this amount, an equal or excessive amount of product escapes from the system as it is metered through the MLLD. Under this condition pressure cannot build up in the piping system. When a nozzle is opened, a poppet in the MLLD moves to a position that restricts the flow to approximately 1.5 to 3 gallons per minute (GPM). Slow dispensing of fuel is the indication to the operator that a leak is present.

If there are no leaks, pressure rapidly builds in the system forcing the MLLD to open to the full-flow position. In a system with no leaks, it takes approximately two seconds for the complete test. No further line testing takes place until the line pressure drops below 1 psi.



The diagram above shows three positions of a typical piston-style MLLD

(1) **Closed, "tripped" or relaxed position**- Under normal operating conditions, it is assumed that the lines are filled with product. When the system pressure is less than 1 psi, the piston and poppet are in their "down" or "tripped" position. The position of the valve poppet is such as to allow approximately 1 ½ to 3 gallons per minute flow into the delivery line through a bypass opening the LLD valve poppet when the

submersible pump starts. Since the systems is full, pressure builds rapidly and the poppet moves to the leak sensing position assuming there is no leak present. The pressure relief valve prevents any guild up of pressure under the piston when in trip position by allowing relief of trapped product.

(2) **Leak sensing position**- As the pressure rapidly builds to approximately 20 to 22 psi the piston has moved the poppet to such a position as to almost stop the flow into the piping through the LLD valve poppet. Older diaphragm-style leak detectors only require 8 to 10 psi to enter leak sensing mode.. In this position, all the flow must then travel around the metering pin which limits it to approximately 3 GPH rate. If a simultaneous loss from the system equals or exceeds this amount, the line pressure will not build beyond this point and the valve will remain in the leak sensing position with the main flow blocked. If there is an attempt to dispense while the valve is in this position, the line pressure will drop, the piston will respond, and the poppet will return to Position 1 where the 1 ½ to 3 GPM will flow to the dispensers.

If the dispensing system (the solenoid valve and the nozzle) is opened previous to the completion of the line test, the LLD will detect this opening as a leak and restricted flow will result. Closing of the nozzle(s) for a period of time, adequate to allow completion of the line test, will allow the LLD to open. This in turn will allow full flow providing there is no additional escape for fuel in the system. If there is no leak in the system, the small flow around the metering pin increases the line pressure to approximately 22 psi in approximately 2 seconds at which point the piston will snap the poppet to Position 3, allowing full flow. Any product relived through the pressure relief valve during trip position will be vented through the vent tube to the tank. This allows the piston to move freely with no back pressure to hamper its movement.

(3) **Non-Leak Position**- This position allows full flow. The poppet will remain in this position as long as the system pressure remains above 1 psi. At less than 1 psi the poppet will return to Position 1 and the next time the pump is activated, the LLD will perform a line test.

A mechanical line leak detector (MLLD) must:

- be able to detect a leak as small as 3 gph at a line pressure of 10 psi as required by rule .04(4)(a). This is the industry "out of the box" standard for mechanical leak detectors. All MLLDs manufactured today are flow restriction devices. Oftentimes, when a leak is detected, the "slow flow" of product at the dispenser will result in the person dispensing product to alert someone working at the facility of a problem.
- have an annual quantitative test conducted in accordance with the Division's requirements to ensure it is operating as designed as required by rule .04(4)(a). If the MLLD can no longer detect a minimum 3.0 gph leak it must be replaced.

NOTE: The leak rate of 3.0 gph at 10 psi is a relative function of pressure, and an exact calibrated standard established by EPA. When a third party evaluates leak detection equipment, the testing equipment is made to pass the liquid through a "simulated orifice" at a rate of 3.0 gph at a standard pressure of 10 psi. Once the hole size has been calibrated, the portion of the test device that limits the flow to 10 psi is removed, and tests at any level of pressure. It must then detect the leak that was previously calibrated. During normal operating pressure, the EPA standard does not require the device to test for a leak at 10 psi, or that the device must detect a 3.0 gph leak. If a high pressure pump is used, the testing leak rate increases in proportion to the STP operating pressure. MLLDs are designed to search for different sized leaks at different operating pressures. This is why a 3.0 gph at 10 psi testing standard is used to verify the device is operating properly.

Examples of Mechanical Line Leak Detectors


Red Jacket DLD (diaphragm)


Red Jacket XLD (extended life diaphragm)


Red Jacket PLD (not 3rd party certified)


Red Jacket XLP (extended life piston)


Red Jacket FXIV Series


Red Jacket FXV Series

FE Petro MLD: gasoline (blue), diesel (tan), and high modulus flex piping (gray)

FE Petro MLD-HC (high capacity)

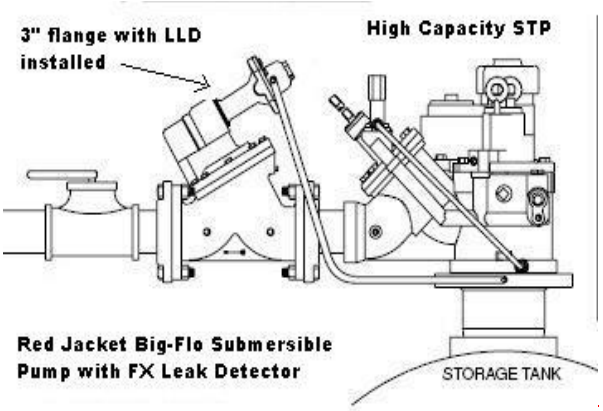
Vaporless 99-LD2000

Vaporless 99-LD3000 (high capacity)

Red Jacket FXV

FE Petro MLD

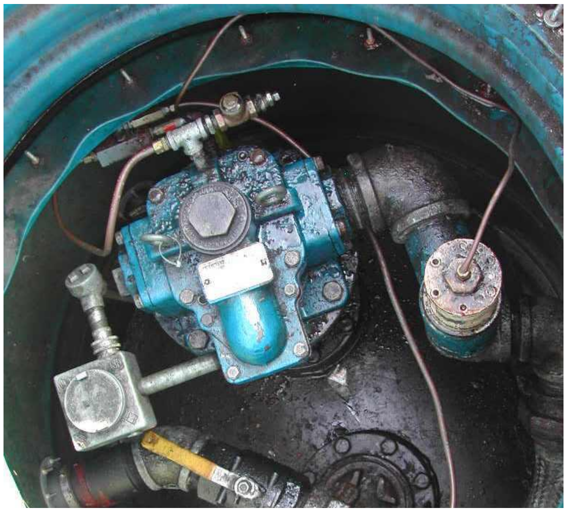
Vaporless LD-2000



COMMON PROBLEMS ASSOCIATED WITH MECHANICAL LINE LEAK DETECTION

1) Improper Installation

Acceptable- see text below



Not acceptable- see text below for explanation

MLLDs are typically installed in a packer port on the top of the STP head unit. Occasionally an installer may choose to install the unit on a T-fitting beside the STP. This is common when STP units were constructed without a packer port (prior to 1975) or if the STP head unit is too close to ground surface. If a leak occurs in the piping or fittings between the MLLD and the STP head, then the MLLD will not detect the leak. The MLLD should be installed in the T-fitting that is designed for it. The MLLD installed in the left photo above is in compliance with these requirements because it is installed in a Red Jacket T-fitting immediately adjacent to the STP head unit. The photo on the right is a FE Petro HC (high capacity) STP head with an adaptor T-fitting located on an elbow fitting. Since the elbow fitting is installed between the MLLD and the STP head, that portion of piping does not have catastrophic line leak detection and should be replaced. If this configuration is in a sump, it will only be considered in compliance if it is monitored by a sump sensor.

2) Vapor Pockets in Piping

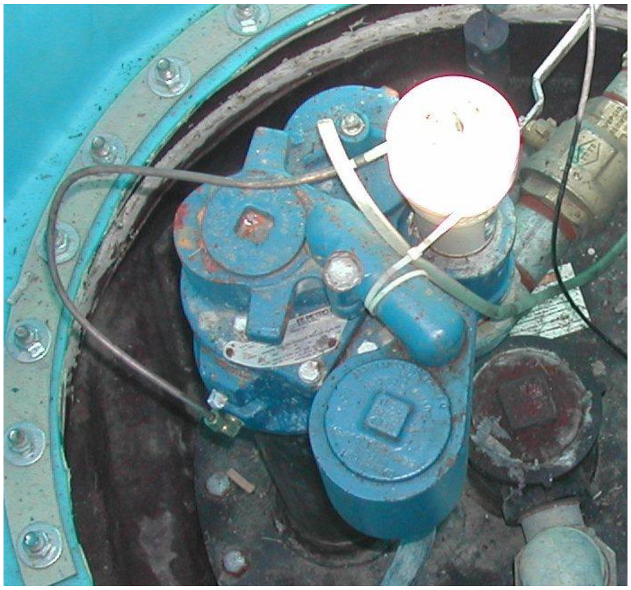
When pressurized piping systems are serviced or MLLDs are removed or replaced, air or vapor can be introduced into the piping system. Piping configurations which include an unused section can also cause false alarms by allowing trapped vapor to accumulate. Any vapor trapped in the piping system will be compressed during routine pressurization of lines prior to each product dispenser activation and cause false alarms or longer piping pressurization times.

3) Improper Vent Tube Installation

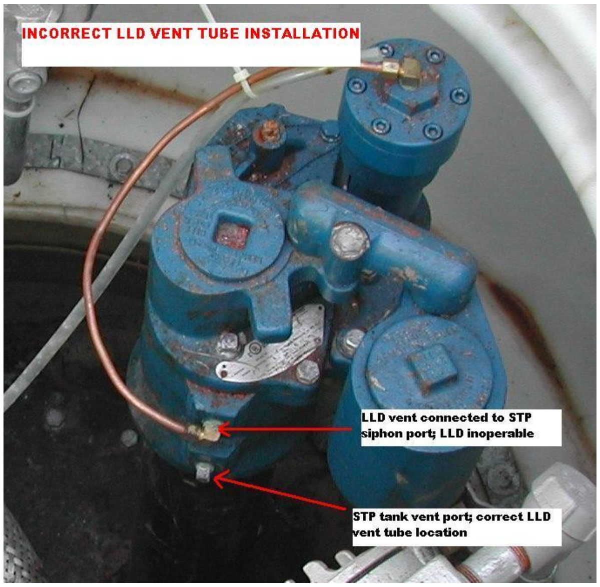
All MLLDs equipped with a vent port must have a copper vent tube installed from the vent port to the STP tank test port in order for product to drain from the MLLD and reset between pump cycles. This is how the system is designed to allow air pockets to be purged from the product lines. This prevents the MLLD from indicating a false line leak

or low flow condition. Some MLLD manufacturers have “ventless” models which release product and air in product lines back into the STP head unit after each test. The owner/operator must provide documentation for the specific device from the manufacturer if MLLDs do not have copper vent tubing installed. If the MLLD manufacturer no longer supports the “ventless” MLLD, the O/O must replace the device immediately. See example below:
This does not include the original DLD and XLD series indicated on page 11.

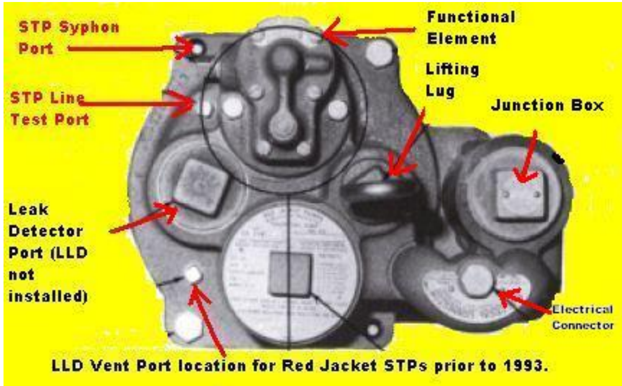
Ventless Red Jacket no longer supported

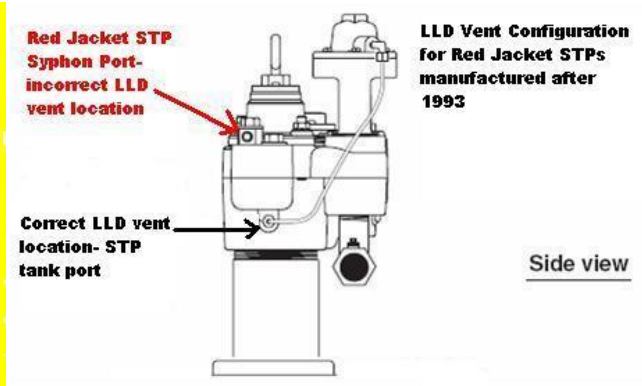


Correct MLLD vent tube installation on FE Petro submersible pump (bottom tank port).



Incorrect MLLD vent tube installation (upper siphon port); MLLD is inoperable.

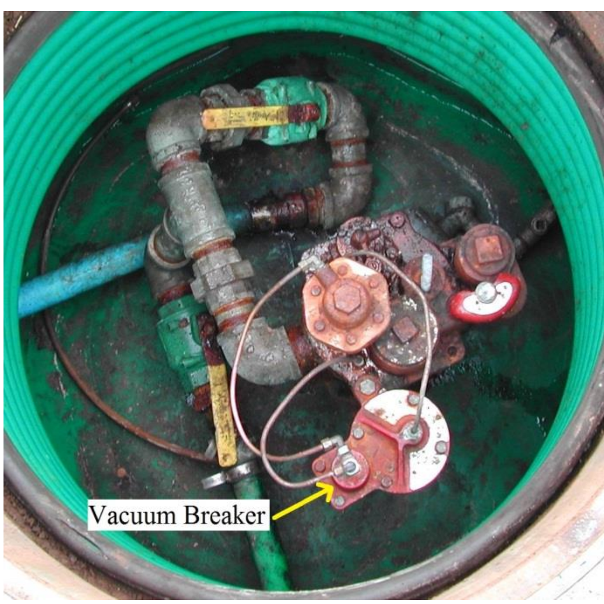


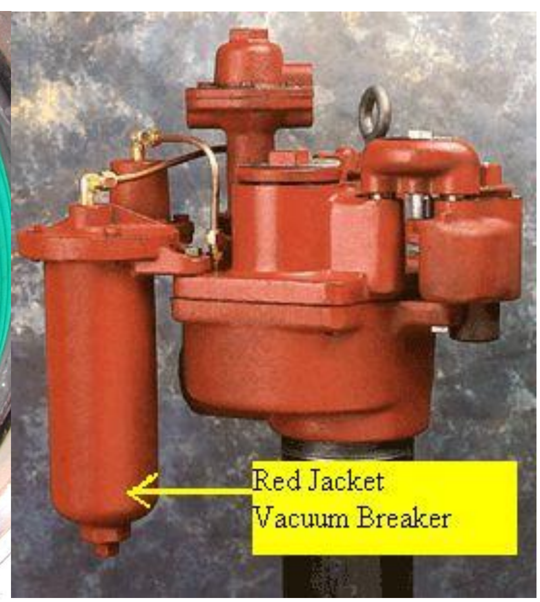


When inspecting facilities with FE Petro STP units, be sure the MLLD is vented to the tank test (lower) port and not the factory-installed siphon (upper) port since this will render the MLLD inoperable. The upper port is used to connect a vacuum line when manifolding two tanks together. The photo above shows the proper configuration. Red Jacket STPs manufactured prior to 1993 have tank port located immediately adjacent to the leak detector port. For Red Jacket STP units manufactured after 1993, the tank port is located on the lower side of the packer beside the piping discharge point. A MLLD is inoperable if the copper vent tube is connected to any location other than the tank vent port.

If a MLLD is documented without vent tubing or is configured improperly, the device may be damaged due to over lifting of the internal diaphragm. The piping system should be deactivated until the MLLD can be tested or replaced.

3) Thermal Contraction



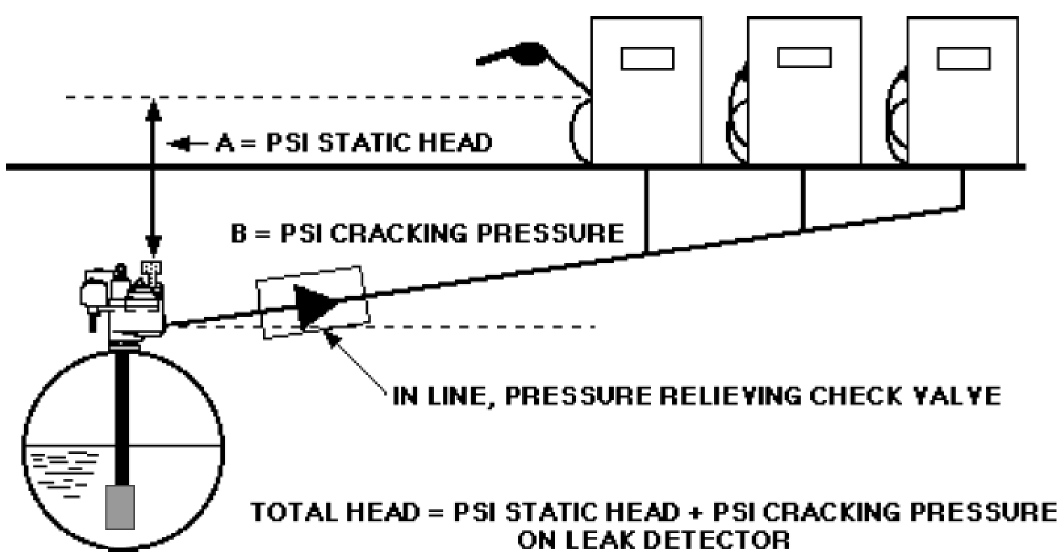


Thermal contraction occurs when the temperature of the product stored in the tank is higher than the temperature in the piping and/or dispensers. When the product is pumped from the tank and contacts the cooler piping, the product contracts. This results in a decrease of product volume in the piping and may cause false alarms by triggering the MLLD into leak mode. This situation can be common in winter months. The Red Jacket vacuum breaker attached in the photo above is designed to eliminate a vacuum from occurring in a product line. Vacuum develops in a system when the temperature drops and product volume contracts, resulting in lower line pressure. Extreme contraction can create a vacuum by reducing pressure to below 0 psi. Under vacuum conditions, components of the fuel delivery system allow air into the product line; significantly increasing the time it takes for the leak detector to perform a test. This delay is an interruption of service known as “false tripping.” In fighting this problem, the vacuum breaker acts as an accumulator. It holds approximately 1.2 quarts (1100 ml) of product and waits for the line pressure to drop below 0 psi. When this occurs, the vacuum breaker releases product into the line, bringing pressure back to 0 psi. If a fueling facility is experiencing restricted flow due to the mechanical leak detector tripping in the mornings and/or after long intervals when no product has been dispensed, installing a vacuum breaker may solve or ease the problem.

5) Continuous STP Pressure

MLLDs are not compatible with UST systems which allow an STP to operate continuously at pumping pressure while dispensers are not in use. If the STP is allowed to run continuously, the MLLD will not reset to the idle position and enter leak detection mode. In this situation the MLLD will not be capable of performing catastrophic line leak detection which is a violation of UST rules .04(1)(a), .04(2)(b)1.(i), and .04(4)(a). While reviewing records, the inspector can verify the STP is cycling properly by confirming the holding pressure is different from the operating pressure as recorded by the tester during the annual MLLD test. An optional method to verify the STP cycles properly is to determine if the STP head does not vibrate when the dispenser is not in use.

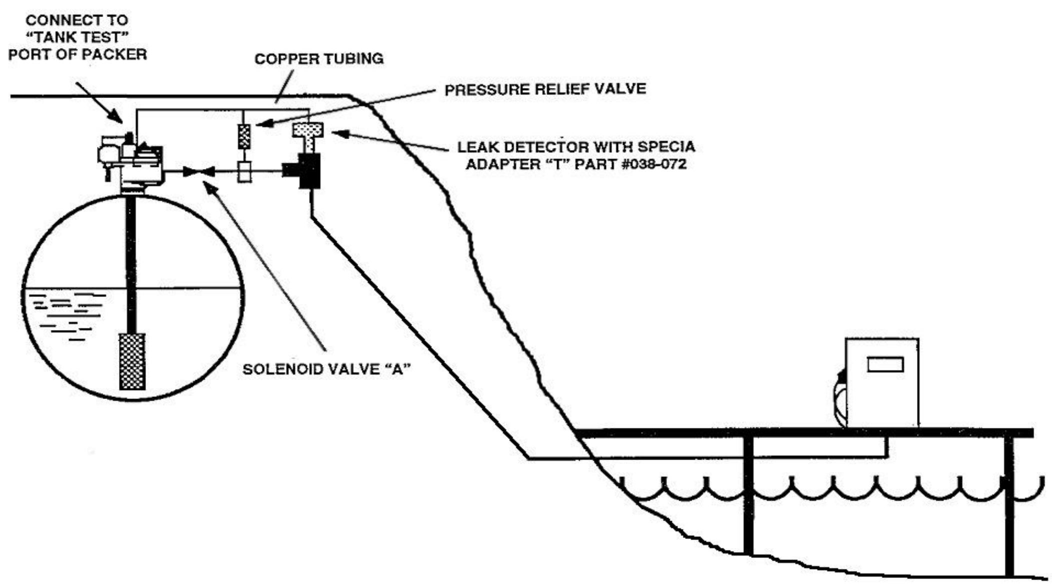
6) Static Head Pressure



Static head pressure can cause MLLD functional problems. This can occur when tanks are buried too deep and as a result, the STP head is located too far underground. Static head pressure is also an issue when dispensers are installed on a slope at a higher elevation from the tank pit. Product in the piping above the MLLD will exert static head pressure of roughly 1.0 psi for every three (3) feet of vertical elevation. This pressure will prevent the MLLD from resetting after each test. The manufacturer recommends a maximum elevation differential of no more than six (6) feet, unless the tank owner can demonstrate the MLLD installed on this system is designed to compensate for higher static head pressure.

In-line check valves installed in the product piping can also allow a potential leak to go undetected. When the STP pressurizes the product piping, additional pressure is needed to open the in-line check valve. This is referred to as “cracking pressure”. The additional pressure created could allow a leak to go unnoticed in the piping beyond the check valve.

7) Downgradient Piping Configurations



Occasionally facilities such as marinas and convenience stores built on a severe downgradient slope may have configurations where portions of the piping are at a lower elevation than the product in the tank. If a leak occurs in the piping, the product in the UST system could potentially be “siphoned” out by the vacuum exerted by the fuel in the piping. In these situations, leak detector manufacturers require the installation of an electronic solenoid or anti-siphon valve to prevent siphoning effects from emptying the tank in the event of a leak. The anti-siphon valve shall be installed between the MLLD and the STP head.

8) Piping Type Compatibility

Some types of flexible plastic piping can expand in diameter under normal operating pressures, allowing additional product in the line which may result in subsequent false alarms or incorrect leak thresholds. This could prevent a leak from being discovered. Some MLLD manufacturers design their products specifically for flexible piping applications to account for piping resiliency. If flexible plastic piping is used, the owner/operator should verify that the make and model of any MLLD in question is compatible with the type of piping used.

9) Product Compatibility

MLLD manufacturers typically code or rate their products based on the viscosity of the product which they will be used. For example, Red Jacket brand MLLDs intended for use with diesel/kerosene products will have a green cap. FE Petro leak detectors are designated by color: blue (gasoline), beige (diesel/kerosene), and gray (flexible piping). MLLDs intended for lower viscosity product such as gasoline will function adequately on diesel or kerosene systems and will actually have a more stringent leak rate. But MLLDs designed for use for diesel piping should not be used on gasoline piping configurations.

10) Tampering/Disabling the LLD

Red Jacket DLD with intake screen and metering pin removed on left

Tampering with a leak detection device is a CRIMINAL OFFENSE.

Rock inserted to disable line leak detector

MLLDs are manufactured to operate independently without being opened or serviced, and must be replaced when they no longer function as designed. MLLDs that are rebuilt, altered or repaired are not acceptable. Evidence of this would include unusual scratches on cap bolts or removal of serial number face plates. **Tampering with a leak detection device is a CRIMINAL OFFENSE**. Also, listen carefully for a 3 to 10 second delay between dispenser activation and the "surge" of full pressure by lifting the dispenser nozzle during an inspection which is a general indicator that the leak detector is working properly.

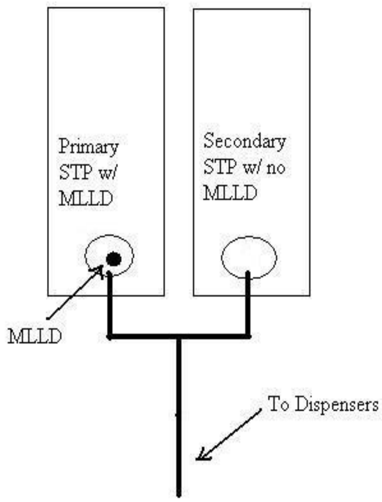
11) Dual Submersible Pump Configurations and Piping Manifolds

The UST piping configuration in the photo above has two STP units manifolded into a single piping system. Tank manifolds (two STP units in one tank) and piping manifolds (two tanks with separate STP units combined into one piping system) are both configured to maintain line pressure at high throughput facilities such as truck stops, bulk plants, or piping run lengths greater than 100 feet with multiple dispensers. The primary STP unit or "master" unit is equipped with an electronic line leak detector (ELLD) while the secondary or "slave" STP unit appears to have no catastrophic line leak detection at all. This configuration may or may not be in compliance, depending on several factors (check valves, STP operating rates, etc.).

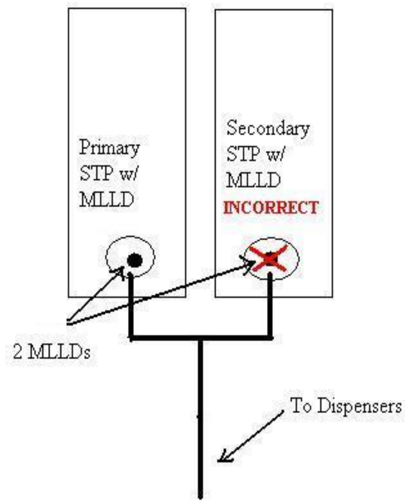
The tank owner should consult a leak detector manufacturer to ensure that any dual STP configurations have the necessary leak detection equipment for compliance.

Below are some examples of common pressurized piping manifold configurations:

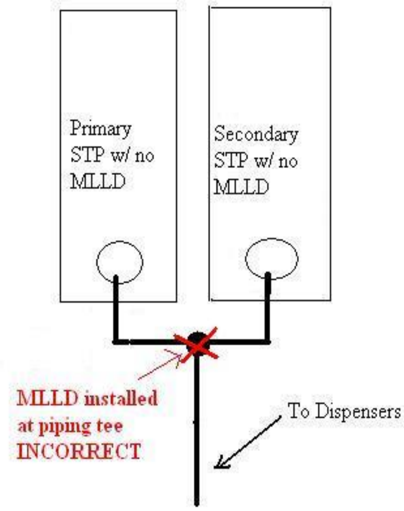
Example 1- two tanks with piping manifold; a single MLLD provides 3.0 GPH for entire piping system, secondary STP provides auxilliary pressure or serves as a backup.



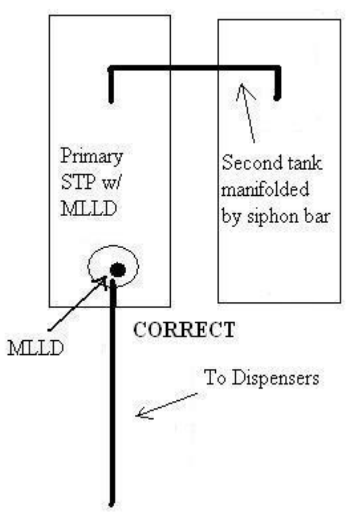
Example 2- two tanks with piping manifold, equipped with two MLLD's. This setup only provides 6.0 GPH catastrophic leak detection to the entire piping system. The MLLD on the secondary STP must be removed.



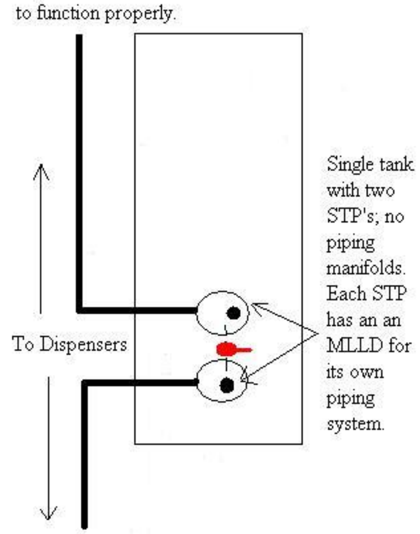
Example 3- MLLD installed at piping manifold; does not provide 3.0 GPH leak detection to piping behind the MLLD. Require installation of MLLD at primary STP.



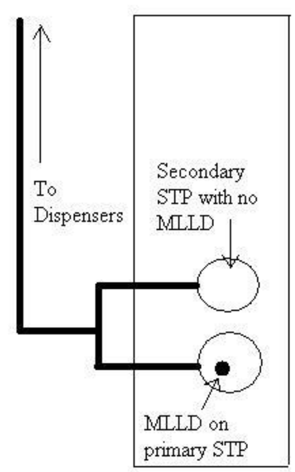
Example 4- siphon bars which connect two tanks together are not required to be equipped with MLLD's. They are suction piping systems which will not function if a leak exists.



Example 5- a single tank may have two STP's to supply product to two separate piping systems. If the piping systems are connected, a piping manifold exists. A permanently closed ball valve is required between the two STP's for the MLLD's to function properly.



Example 6- single tank with two STP's and a piping manifold. The MLLD must be installed on the primary STP. Only one check valve can be installed as close as practical to the secondary STP for the MLLD to function properly.



NOTE: Alternating STP configurations with piping manifolds use an Automatic Tank Gauging system to determine which STP to activate according to which tank contains the most fuel. With this configuration, two STPs within a single piping system may be equipped with two MLLDs. Depending on which STP is activated, both MLLDs can test the entire piping system alternately and not interfere with the allowable leak threshold.

If inspectors encounter pressurized piping manifold configurations with two MLLDs, the MLLD manufacturer must verify the setup will be adequate to detect a leak. Annual testing of the MLLDs by simulating line leaks will not confirm an incorrect STP controller setup, since testing is done on each MLLD separately.

ELECTRONIC LINE LEAK DETECTORS

ELLDs are commonly used at UST facilities to meet piping leak detection requirements for catastrophic (continuous 3.0 gph), monthly monitoring (monthly 0.2 gph), and annual testing (yearly 0.1 gph) testing requirements see rules .04(1)(a), .04(2)(b) and .04(4). ELLDs can be used on any UST system which utilizes pressurized piping; however, they are more commonly found at newer installations. The significant advantage of electronic line leak detection is that the system can usually interface with an automatic tank gauging system of the same manufacturer and send continuously updated piping system information to an off-site owner or contractor via telemetry (i.e. telephone line). It is now common for tank owners with ELLDs to receive piping test and alarm information at their office, which makes recordkeeping, maintenance, and leak investigations more effective.

An ELLD system consists of an electronic pressure transducer or flow meter that is mounted on the STP head where a mechanical leak detector would normally be installed. The ELLD is connected to either an ATG console or a stand-alone control panel by a signal wire or through the existing STP relay electrical conduit. The control panel or ATG is programmed to conduct line leak testing by use of one of the following methods:

1. **Pressure decay ELLDs** use a microprocessor to measure pressure loss over a preset period of time. The product piping is pressurized by the STP, and a check valve in the STP maintains the line pressure. The ELLD system can cycle the STP on and off one or more times during the test to increase test pressure lost due to thermal contraction of fuel.

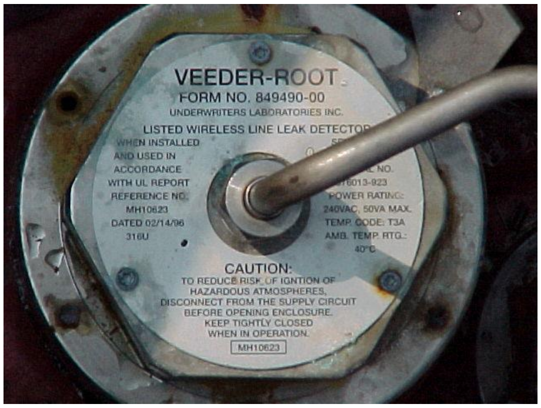
2. **Constant pressure ELLDs** which measure volume displacement by leaving the STP active during the test period, and monitoring the level of liquid lost from the piping during inactivity using an electronic flow meter. As fuel leaks from the line, the meter measures the rate at which the leak fuel is replaced in the line. It will continue to monitor until the leak rate is steady, or until no loss of fuel is detected.

Much like mechanical line leak detectors, ELLDs conduct a catastrophic 3.0 gph leak between each fuel dispenser activation. The primary difference is that while mechanical devices are designed to alert the operator of a problem by restricting flow of product to the dispenser, ELLD devices are designed and installed to completely shut down the flow of product to the dispenser, or activate an audible/visual alarm.

IMPORTANT: At unmanned facilities or at 24 hour facilities which do not have an operator present, the Division will require, under rule .04(1)(e), that the ELLD completely shut down flow to the dispenser even if an audible or visual alarm is present. The Division takes this position on ELLDs because no operator is present to respond to the alarm and shut down flow.

Examples of Electronic Line Leak Detectors

Veeder Root PLLD



Veeder Root WPLLD

The Veeder Root Wireless Pressurized Line Leak Detector (WPLLD) uses a pressure transducer and check valve located where the LLD would usually be installed. An electrical switch is connected to the STP capacitor, utilizing existing electrical connections of the STP to communicate with an automatic tank gauging console. If the device detects a loss of line pressure, the electrical switch does not allow the capacitor to charge, thereby preventing the STP from pumping product. This unit can detect leak rates of .1, .2 and 3gph. **The Veeder-Root WPLLD is not approved for use with flexible plastic piping as seen in the photo above.**

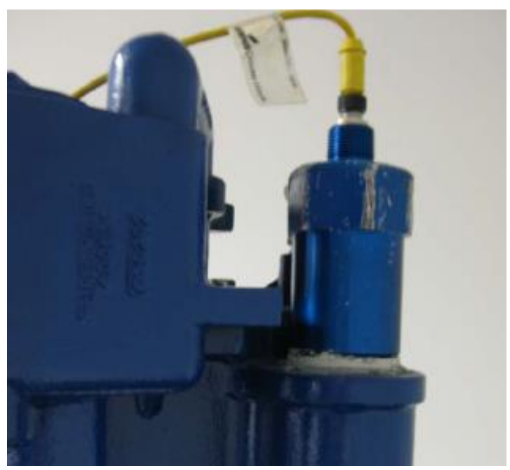
Incon TS-LLD (Franklin Fueling)

The Incon TS-LLD is a volume displacement ELLD that can be installed as a stand alone device with an electronic interface console (above) or connected directly to an Incon automatic tank gauging system. The TS-LLD is available in two models for rigid and flexible piping (verify model number for compatibility during inspection). It is compatible for UST systems containing gasoline, diesel, AV fuel, and fuel oil (<u>not E85 compatible</u>).

NOTE: Franklin Fueling does not recommend use of the TS-LLD at high volume facilities where piping throughput exceeds 10 gallons per minute or that have 4 or more dispensers active at one time.

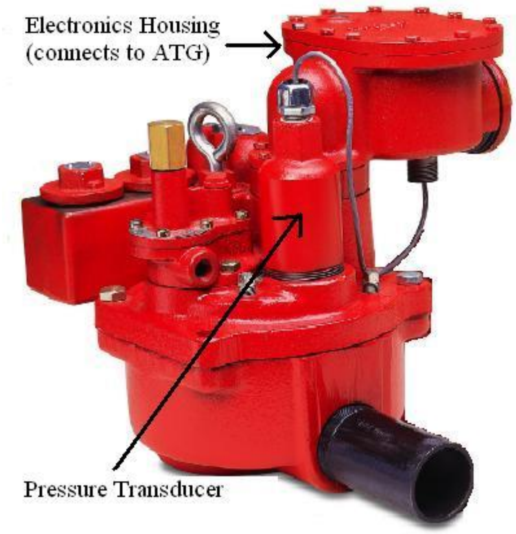
Incon TS-LS300 and LS500 Autolearn

Incon TS-LS300 (stand alone ELLD)



Incon TS-LS500

The Incon Autolearn ELLD systems pictured above consist of a pressure transducer in the line and a microprocessor in the monitoring console to evaluate the data from the transducer. The functional element is set above the STP operating pressure so that when the STP is shut off, the system will be able to detect a leak based on the pressure drop. These ELLD devices record the piping system's characteristics during initial start-up testing, thus allowing for variations in system variables such as piping resiliency and configuration such as the amount of rigid vs. flexible piping in a hybrid system.



Red Jacket Linemaster Pressure Transducer ELLD

The Red Jacket Linemaster Electronic Line Leak Detector is used with Red Jacket PPM 4000 or RLM 9000 Automatic Tank Gauging Systems. In addition to STP shutdown features and a leak report generated by the ATG, a series of LED lights are visible through a sight glass on the electrical housing to alert the operator or technician if leaks are detected or tests are being conducted.

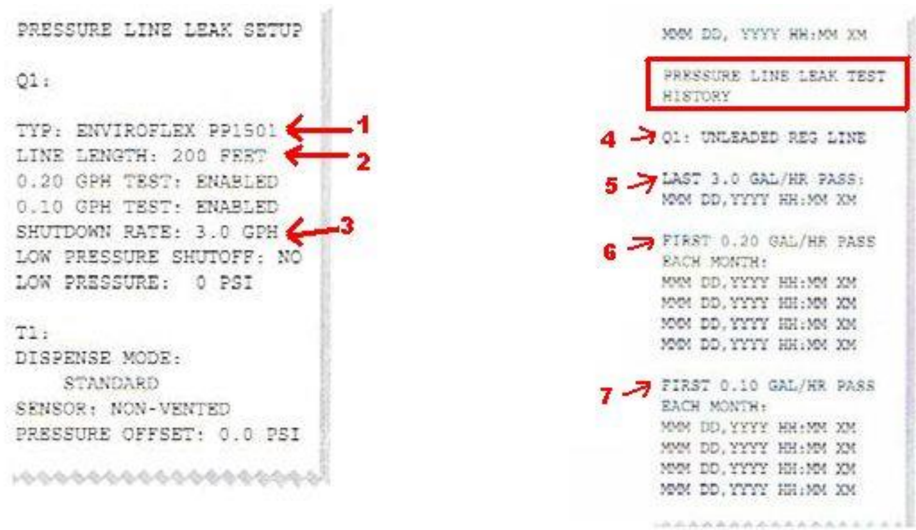
Campo/Miller LS-300 Pressure Transducer ELLD

The interface console for the LS-300 can be installed on the dispenser or inside the facility. The pressure transducer is connected at the STP or below the shear valve. Although the Campo Miller device has been discontinued, the technology is now incorporated in the device manufactured by Franklin Fueling as the Incon TS-LS300 Autolearn (see photo on previous page). Where the Campo Miller device is installed, it must be visually checked on a weekly basis by the operator, and a full function test must be conducted every 30 days according to manufacturer's instructions and third party certification. The minimum leak threshold of this device is 2.36 gph, and therefore is only suitable for 3.0 gph catastrophic leak detection. **Since**

this device only has audible and visual alarms, it may not be used at unmanned facilities under rule .04(1)(e). Annual line tightness testing, interstitial monitoring, or SIR must also be conducted to meet the requirements of monthly release detection, see rules .04(1)(a), .04(2)(b)1., and .04(4).

COMMON PROBLEMS ASSOCIATED WITH ELECTRONIC LINE LEAK DETECTION

1) Improper Installation/ Programming



Veeder Root ELLD Setup Information to be verified:

1. Piping Type- determines piping resiliency, ELLD test results invalid if information is incorrect.
2. Line length- line length set too long: test result incorrect. Must be accurate to within 30% of actual line length.
3. Shutdown Rate- adjustable setting to 0.1, 0.2, 3.0 gph or NONE. <u>No catastrophic line leak detection if NONE is selected.</u>
4. ELLD Piping Label- required to verify ELLD location and test result.
5. 3.0 gph Passing Test Result- required for 3.0 gph catastrophic leak detection.
6. 0.2 gph Passing Test- optional to meet monthly monitoring option.
7. 0.1 gph Passing Test- optional to meet annual line tightness test option.

If ELLDs are used for monthly (0.2 gph) or annual (0.1 gph) leak detection requirements, they must be programmed by the installer or a certified technician to ensure tests are conducted properly. Factors such as piping type, resiliency and length must be set to prevent frequent false alarms and verify the ability to detect a leak, see rules .02(1)(c), .03(1)(e), and .04(1)(a) and (b). Inspectors should require a "Pressure Line Leak Setup" report every six years generated from the tank monitor or other interface console to verify these parameters are set up properly. If programmed piping length is set at 30% or greater than fifty (50) feet of actual piping length, the

ELLD catastrophic leak rate will likely exceed 4 gph, and the device will not detect a leak properly.

Also, certain variable speed submersible pumps such as the FE Petro Model IST-VFC must have adjustable pump startup and pressure settings properly set to obtain valid leak test results. Veeder Root PLLD leak detection systems may generate an invalid passing line leak test result, if these settings are not configured properly. Refer to Veeder Root PLLD Installation Guide (576013-902) for more information when FE Petro variable speed submersible pumps are installed.

2) Submersible Pump Component Failure

A field study was conducted on electronic line leak detector field performance by Ken Wilcox Associates in 2007. This study revealed that when FE Petro submersible pumps are equipped with Veeder Root PLLD electronic line leak detectors, the PLLD was able to detect a simulated 3.0 gph leak in only 58% of test conducted. FE Petro STPs manufactured prior to 2008 were equipped with a siphon jet assembly that can fail, causing the PLLD to miss leaks. Veeder Root has issued a maintenance bulletin (Manual 577013-344, Rev. H, PLLD & WPLLD Troubleshooting Guide) to address the problem, and FE Petro has redesigned the siphon jet assembly in STPs manufactured after 2008. These types of problems emphasize that even if ELLDs do not experience technical issues which affect their test results, other UST system components may fail which can invalidate test results. Therefore, annual testing of these devices is even more important.

3) Routine Service and Calibration

Some ELLD manufacturers claim their products are "self diagnostic" and do not require routine functionality checks. However, all 3rd party approved ELLDs listed on the National Work Group on Leak Detection Evaluations (NWGLDE) website require annual service checks and calibration. All ELLDs shall be tested on an annual basis in accordance with the Division's Precision Line Tightness and Leak Detector Test Report form CN-1341 (see Appendix B and rule .04(1)(e)).

4) STP Positive Shutdown

Unlike mechanical leak detectors which "restrict flow" when a 3.0 gph leak is detected, some ELLD configurations can be programmed to only alert the operator with a visual/audible alarm on the interface console. If these alarm warnings are acknowledged and then ignored, a leak may go undetected for a long period of time. All ELLD systems manufactured today are capable of positive shutdown of the STP. Some older models such as the Campo/Miller LS-300 do not provide this function. In accordance with rule .04(4)(a), the ELLD should be programmed to provide positive STP shutdown or a continuous audible alarm to alert the operator of a problem except at unmanned facilities when positive shutdown is required in accordance with .04(1)(e). This function may be verified in the device's Line Leak Setup Report or by a certified technician.

5) Piping Type Compatibility

The Veeder Root WPLLD "wireless" pressurized electronic line leak detector pictured above is not compatible with flexible plastic piping configurations because they do not account for piping deflection and expansion under operating pressure. This type of ELLD is identified by the aluminum conduit on top of the unit that connects to the STP head to transmit data to the ATG. In accordance with rule .04(1)(e), facilities with WPLLD style leak detectors which have flexible plastic piping must replace the ELLD unit with a device which is 3rd party certified for use with flexible piping.

6) Recordkeeping

Certain ELLD systems such as the Incon TS-LLD which are not interfaced with an ATG console will not generate a written test report or line leak test. Instead they use an interface console that alerts the operator with a series of codes flashed on an LCD display. To comply with recordkeeping requirements for leak detection, owner/operators utilizing this type of ELLD equipment should maintain a written log to verify the device is monitored on a monthly basis. See rules .03(2)(b)4. and .04(5).

Testing of Mechanical & Electronic Line Leak Detectors

All manufacturers of mechanical and electronic line leak detectors require their products be tested upon installation and at least annually thereafter. The Division has determined that "functional" or qualitative testing does not ensure that line leak detectors can adequately detect a release, because to define an automatic line leak detector as simply "functional" does not necessarily mean the device can meet the 3.0 gph at 10 psi standard required by rule .04(4)(a). For example, if a MLLD has degraded over time to the point that it can only detect a 5.0 gph leak at 10 psi, it would not meet the requirements of rule .04(4)(a).

The Division has developed form CN-1341 Precision Line Tightness and Leak Detector Test Report (see Appendix A) for submitting line leak detector test results in accordance with rule .04(4)(a) to help tank owners and service providers to comply with rules .04(5)(b) and .04(5)(c). The data required on this form are important to determine if each 3rd party approved testing procedure is being followed properly.

REQUIREMENTS FOR LINE TIGHTNESS TESTING

If line tightness testing is selected, rule .04(2)(b)1.(ii) requires that it must be conducted annually by a tester certified by the method manufacturer. If the manufacturer requires the tester to be certified, then the tester must maintain current certification for the results to be acceptable under rules .04(1)(a)2. and .04(5). A line tightness test must be able to detect a leak as small as 0.1 gallon per hour at one and one-half times normal operating pressure as required by rule .04(4)(b). There are currently several third party approved line tightness testing methods which can be used to satisfy the annual 0.1 gallon per hour (gph) testing requirements. The primary types of line tightness testing methods are:

1) Constant Pressure Volumetric Line Tightness Testing

Petro Tite Line Tester

Acurite Line Tester

Tanknology TLD-1 Line Tester

This method of line tightness testing involves the additional pressurization of product piping using a hand operated hydraulic pump or inert gas such as nitrogen to introduce additional pressure. Over a pre-determined period of time, the tester monitors the change in pressure in the product line using a pressure gauge. The Petro Tite line tightness test method uses constant pressure adjustments by adding additional fuel to the line. This method requires the tester to compensate for product line expansion, resiliency of flexible plastic piping, or flex connectors and compensate for these factors in the test as "allowable bleedback". Bleedback may be determined at the end of the test when piping pressure is reduced to zero. The amount of product collected in the volumetric cylinder at zero operating pressure is compared to the pre-determined amount of allowable bleedback. If the amount of product recovered is less than the allowable bleedback, the possibility of a leak exists. A 90 psi pre-test is required when flexible piping, flex connectors or piping diameters greater than 3 inches are encountered in order to account for piping expansion. The Petro Tite Line Tester, Acurite Line Tester, and Tanknology TLD-1 Line Tester are examples of this type of device.

2) Electronic Pressure Transducer Line Tightness Testing

The difference between this type of line tightness testing and volumetric methods is that the pressure decay method uses a field installed electronic pressure transducer to monitor a series of pressure changes over a pre-determined period of time. The method uses a pressure gauge to monitor the change in pressure. The MassTech ML3P line tightness testing method is an example of this type of device. Electronic line leak detectors which are permanently installed in a pressurized piping system also utilize pressure transducers and can be utilized to meet line tightness testing requirements. Although regulations require line tightness testing be conducted at one and one half times operating pressure, ELLDs utilize mathematical algorithms to simulate increased testing pressures and satisfy third party testing requirements for monthly monitoring and line tightness testing in rules .04(1), .04(2)(b)1.(ii) and .04(4).

3) External Line Tightness Testing

Currently the PraxAir (former Tracer Research) Tracer Tight method is the only external method which is NWGLDE third party approved to meet 0.1 gph at one and one half times operating pressure requirements for tank and line tightness testing in rule .04(4)(b). This method involves installation of sampling probes in the vicinity of the tank and/or piping trench. The soil probes can be installed permanently and re-used on an annual basis. A proprietary tracer chemical is introduced directly into the UST system. The tracer mixes with petroleum product in the tank and does not require the UST system to be shut down. The tracer chemical will escape into the surrounding soil if a leak exists. Air/vapor samples are collected from the sample probes and analyzed for the presence of the tracer at concentrations as low as 10 parts per trillion. The length of test time is variable depending on tank size, product volume in tank, and frequency of product delivery according to manufacturer's instructions.

Factors such as soil permeability and the presence of bedrock or ground water in the vicinity of the piping trench may affect the test procedure.

COMMON PROBLEMS ASSOCIATED WITH LINE TIGHTNESS TESTING

1) Vapor Pockets and Vapor Expansion in Piping

Vapor pockets frequently occur when piping systems have been serviced, leak detectors are replaced, or when piping systems are not used frequently, such as premium gasoline or seasonal kerosene. Vapor pockets are also common in new installations before large amounts of fuel have flushed out all vapor pockets. If one or more dispensers have been removed and the product piping was not properly isolated or removed, vapors will collect in these "dead end" piping terminations and make line tightness testing difficult. Pressurized liquid will force the vapors to contract and possibly give a false indication of leaks. Line testers should purge vapor pockets before completing line tests if the tester suspects they are present. Volume reading variations of 0.30 gallons or greater between tests periods may indicate the presence of vapor pockets in the piping system.

2) Piping Deflection

When flexible plastic piping or steel flex connectors are installed in a piping system, volumetric and pressure decay line tightness testing methods must account for the ability of the piping system to expand under additional testing pressure. Flexible piping systems all have different rates at which they will expand. The amount of expansion of piping relative to the increase of liquid volume within the piping under a known pressure is known as resiliency. Testers must be able to compensate for the ability of flex piping and flex connectors to expand, which in turn causes volumetric loss and possible false leak test results. Allowable bleedback is a standard which third party testers can use to determine whether the amount of allowable expansion has occurred.

Line tightness testers can calculate allowable bleedback by knowing the specific resiliency of the piping, length of piping, and number of flex connectors installed in each piping system. Once the test is complete, the pressure is removed from the piping system and the exact amount of product in the line is measured in a volumetric burette. A one-hour pre-test at or above test pressure can also be conducted to eliminate the effects of pipe deflection in test results. Electronic devices such as Veeder-Root's PLLD use adjustable settings programmed at installation to compensate for piping type, length and expansion during line tests.

3) Thermal Contraction

When petroleum product in a piping system cools, it will tend to contract. This reduces the overall volume of product in the line even though no product has been released into the environment. A third party line tester may incorrectly interpret this reduction in volume as a loss of product. Thermal contraction most often occurs in any area where there is a significant change in daytime and nighttime temperatures. In some cases, thermal contraction may occur when a delivery of warm product is placed into the UST system and begins to cool.

4) Thermal Expansion

When petroleum product warms in a shallow piping trench or in geographic areas with significant daily temperature changes, the increase in liquid temperature will cause the product volume to expand. This condition may offset the loss of product due to leakage. A line testing device may not be able to detect a product loss if thermal expansion occurs. In some instances thermal expansion may occur when a delivery of cold product is placed in the tank and begins to warm in shallow piping trenches to the surrounding ground temperature. Most tightness testing methods require a period of time sufficient for the product temperature to stabilize with the ground temperature before beginning testing.

RECORDKEEPING REQUIREMENTS FOR PRESSURIZED PIPING

All records must be kept at the UST site and be immediately available for inspection by the Division, or at a readily available alternative site and be provided for inspection to the Division upon request. See rule .03(2)(c)1.(i) and (ii).

PIPING INSTALLATION, MAINTENANCE, AND REPAIR

All records documenting the replacement of piping must be maintained for the operational life of the UST system. See rule .02(6)(f). Records of UST system piping repairs must also be maintained for the operational life of the system. See rule .02(7)(f).

Records of all calibration, maintenance, and repair of release detection equipment that is permanently located on-site, must be maintained for at least one year after the servicing work is completed. See rules .04(5)(c) and .03(2)(b)4. Any schedules of required calibration and maintenance provided by the release detection equipment manufacturer must be retained for five (5) years from the date of installation.

PIPING LEAK DETECTION RECORDS

1) Annual Line Tightness Testing

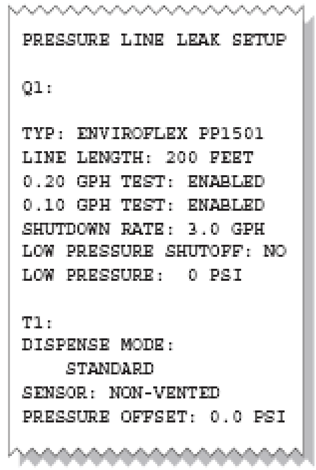
Results of the most recent line tightness testing must be maintained as required by rules .03(2)(b)4. and .04(5)(b). Results of testing shall be recorded on the Division's Precision Line Tightness and Leak Detector Test Report form CN-1341 and maintained for at least one year. See rules .03(2)(b)4., .04(4)(a) and (b) and .04(5)(b).

2) Mechanical line leak detectors

Must be tested annually as required by rule .04(4)(a), and results maintained for at least one year as required by rule .04(5)(b) and .03(2)(b)4. The results shall be recorded on the Division's Precision Line Tightness and Leak Detector Test Report form CN-1341 as required by rule .04(5).

3) Electronic Line Leak Detectors

Must be tested annually as required by rule .04(4)(a), and results maintained for at least one year. The results shall be recorded on the Division's Precision Line Tightness and Leak Detector Test Report form CN-1341. ELLD setup must also be verified every six years during UST Operations Inspections by providing a copy of the Pressure Line Leak Setup Report at the time of the inspection as required by rules .04(1)(a)2. and .03(2)(b)4. This is required to verify site specific settings such as piping type, piping length and compatibility.

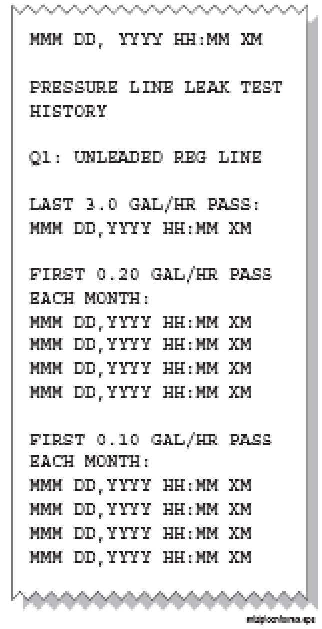


PRESSURE LINE LEAK SETUP

Q1:

TYP: ENVIROFLEX PP1501
LINE LENGTH: 200 FEET
0.20 GPH TEST: ENABLED
0.10 GPH TEST: ENABLED
SHUTDOWN RATE: 3.0 GPH
LOW PRESSURE SHUTOFF: NO
LOW PRESSURE: 0 PSI

T1:
DISPENSE MODE:
STANDARD
SENSOR: NON-VENTED
PRESSURE OFFSET: 0.0 PSI



MMM DD, YYYY HH:MM XM

PRESSURE LINE LEAK TEST
HISTORY

Q1: UNLEADED REG LINE

LAST 3.0 GAL/HR PASS:
MMM DD,YYYY HH:MM XM

FIRST 0.20 GAL/HR PASS
EACH MONTH:
MMM DD,YYYY HH:MM XM
MMM DD,YYYY HH:MM XM
MMM DD,YYYY HH:MM XM
MMM DD,YYYY HH:MM XM

FIRST 0.10 GAL/HR PASS
EACH MONTH:
MMM DD,YYYY HH:MM XM
MMM DD,YYYY HH:MM XM
MMM DD,YYYY HH:MM XM
MMM DD,YYYY HH:MM XM

Examples of Pressure Line Leak Setup and Line Leak History Reports from the Veeder Root TLS-350 (PLLD)

TRANSFER OF RECORDS UPON CHANGE OF OWNERSHIP

Upon transfer of ownership, including, but not limited to, sale of the UST systems, originals and/or copies of all documents required to satisfy the reporting and recordkeeping requirements shall be transferred to the new owner of the USTs at the time of ownership transfer. See rule .03(2)(d).

REPORTING

The following constitute a suspected or confirmed release and shall be reported within 72 hours:

- Results of any failed line tightness tests. See rules .04(1)(b) and .05(1)(a)3.
- Results of any failed test results from an electronic line leak detector. See rules .04(1)(b) and .05(1)(a)3.
- Any unusual operating conditions observed such as erratic behavior of the dispenser (e.g., slow dispensing or tripped leak detector), a sudden loss of product, or an unexplained presence of water in the tank, or if results from the release detection indicate a suspected release. However, the owner/operator is not required to report if the system equipment is found to be defective, but not leaking, and is immediately repaired recalibrated, or replaced and further monitoring does not confirm the initial result. See rules .05(1)(a)2. and .04(1)(b).

REFERENCES

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Field Evaluation Study of ATG Systems, Electronic Line Leak Detection Systems, and Mechanical Line Leak Detectors, Ken Wilcox Associates for California SWRCB UST Program, June 2007

Vaporless Manufacturing Technical Bulletin 060200, June 2, 2000

Vaporless Manufacturing Technical Bulletin 070704, July 7, 2004

Iowa UST Compliance Inspection Guide, July 2007

Mississippi Department of Environmental Quality, ALLD Testing Form, July 2011

Kentucky UST Inspectors Handbook, May 2006

Wisconsin COMM 10 (Incon TS-LLD and LS-300 Autolearn)

Veeder Root Manual 576013-623 AA: TLS-3XX Series Consoles, System Setup Manual

Veeder Root Manual 577013-465 Rev. G: Electronic Line Leak Detectors App. Guide

Veeder Root Manual 577013-814 Rev. D: LLD Systems Operability Testing Guide

Veeder Root Manual 577013-344 Rev. H: PLLD & WPLLD Troubleshooting Guide

Veeder Root Manual 577013-727 Rev. B: PLLD/WPLLD Alarm Quick Help

Veeder Root Manual 576013-902: PLLD Site Prep and Installation Guide

Appendix A

Precision Line Tightness and Leak Detector Test Report

(Modifications are made to these forms periodically. Please check the Division's website for the most current version of the State's official form)

Appendix B

Mississippi Department of Environmental Quality Line Leak Detector Test Instructions (Mechanical and Electronic)

Appendix C

Examples of Electronic Line Leak Detector Test Reports

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF UNDERGROUND STORAGE TANKS
4TH Floor, L & C Tower, 401 Church Street
Nashville, TN 37243-1541

PRECISION LINE TIGHTNESS AND LEAK DETECTOR TEST REPORT

All applicable sections of this report must be legibly completed in their entirety, documenting all results of the tightness testing and automatic line leak detector (LLD) tests. Qualitative or “Functional” testing of Automatic LLD’s is not acceptable.

- Complete section I through IV for all test being conducted.
- Complete section V when testing Mechanical LLD’s.
- Complete section VI when testing Electronic LLD’s.
- Complete IX and X for line tightness tests.
- The owner/operator of the underground storage tank (UST) system is to maintain a copy of this report for a period of 12 months or until next test is conducted.

I. UST FACILITY		II. UST OWNER
UST Facility ID #:		Name/Company:
Facility Name:		Address:
Address:		City, State, ZIP:
City:	County:	Phone #:

III. LINE TIGHTNESS/LLD TESTER	
Tester’s Name:	Company:
Address:	Phone #:
City, State:	Name of Testing Device:
Date of Test:	Tester Certification #:
Tester Certification Date:	Date of Device Calibration (if required):

IV. PIPING & UST SYSTEM INFORMATION

- Each line # below should correspond with the most recent Notification for Underground Storage Tanks (CN-1260).
- All piping repairs and/or replacements must be submitted and authorized by the division in advance.
- Contact the Division of UST for approval if piping repairs and/or dispenser replacements are to be conducted.
- An additional copy of this report is to be completed if more than five (5) product lines are in use at the facility.
- Indicate (N/A) in non-applicable sections below if line tightness testing is being conducted on suction systems.

Reason for Test: ☐ Routine (Annual) ☐ New Installation ☐ Repair ☐ Release Investigation

	Line #/ Product	Line #/ Product	Line #/ Product	Line #/ Product	Line #/ Product
Piping Material: (**ST**, **FRP**, **Flex** Plastic)					
Piping Manufacturer					
Pipe Diameter (inches)					
Length of Pipe (ft)					
Type of Product: **Gas**, **Diesel**, **Kerosene**, Other					
LLD Manufacturer:					
LLD Model:					
LLD Serial #:					
LLD compatible with product/piping type?(Y/N)					
Dispenser shear valves functional? (Y/N)					
STP cycles on/off properly? (Y/N)					

Facility ID#:	Line #/ Product	Line #/ Product	Line #/ Product	Line #/ Product	Line #/ Product

V. MECHANICAL LINE LEAK DETECTOR (MLLD) TEST DATA

- The test must be conducted with the LLD installed in the UST system during the test as during normal operation.
- The test requires the simulation of a leak in the UST system piping equivalent to 3 gallons per hour (gph) at 10 pounds per square inch (psi), **which is equivalent to 190 ml/min**.
- The test must be conducted at the dispenser located at the furthest point above or away from the LLD.
- Each product line above shall correspond with the tank # assigned on the most recent UST Notification Form.

Operating Pressure (psi)					
Holding Pressure (psi)					
Metering Pressure (psi)					
Opening Time (sec)					
Bleedback (gallons)					
Leak Rate in Gallons Per Hour (gph)					
LLD remains in Slow Flow over 30 Seconds? (Y/N)					

VI. ELECTRONIC LINE LEAK DETECTOR (ELLD) TEST DATA

- If required by the ELLD manufacturer, this test shall only be conducted by a certified technician.
- The ELLD must shut off flow or have an audible or visual alarm and must detect a leak equivalent of 3.0 gph at 10psi.
- The technician or tester must verify programmable pump and ELLD settings such as piping type and length.
- Each ELLD must be tested for a minimum of 15 minutes.
- Attach copies of line leak setup from the monitoring console to this report if applicable.

ELLD Setup Correct?(Y/N)					
Simulated Leak Equivalent to 3.0 gph @ 10 psi? (Y/N)					
Simulated leak initiated an audible or visual alarm? (Y/N)					
Simulated leak initiated submersible pump shutdown? (Y/N)					
# of dispensing cycles before STP shutdown:					

VII. LLD TEST RESULTS

A failing test result must be given if any portion of product piping is not monitored by the LLD.

PASS/FAIL					

VIII. NOTES

- List any on-site conditions discovered which prevented LLD test completion.
- List unusual operating conditions found during the test such as but not limited to thermal contraction or air pockets.
- List any repairs recommended or conducted prior, during, or after test completion which must be addressed or reported.
- If a LLD fails the test it must be replaced immediately before placing the piping back in service.
- Indicate if there is any equipment preventing the LLD from monitoring the entire portion of piping, such as in-line check valves, inoperable shear valves, piping manifolds, satellite dispensers, or master/slave submersible pump configurations

____

____

____

____

Tester's Signature:	Date:

IX. PETRO TITE® LINE TIGHTNESS TEST FORM

- Complete one (1) test page for each product line at the facility.
- Test must be conducted for a minimum of one hour at 1.5 times maximum operating pressure, unless otherwise stated in the certification of the testing method.
- Pressure and volume readings must be taken at 5 to 15 minute intervals.
- Allowable bleedback must be calculated if flex connectors or flexible plastic piping is installed, or if piping diameter is greater than 3 inches.
- The method used for testing must be 3rd party certified and compatible with the type of piping installed.
- Page 1 of this form must also be completed in order for test results to be valid.

Facility ID #:	Name of Tester:
Facility Name:	Certification #/Certification Expiration Date:
Line #/ Test Location:	One hour pretest required for 3" piping or flexible plastic? (Yes/No)
Product Type:	Pump Model and Type (STP or Suction):
# of Flex Connectors installed:	STP Operating Pressure (psi):
Ambient Air Temperature:	Type of Cover (Asphalt, Concrete, etc.):
	Approximate Burial Depth of Line (in.):

Time (Military)	Event Description	Pressure (psi)		Volume (gallons)			Comments/Actions (List leaks observed even if repairs are made and retest passes)
		Before	After	Before	After	Net Change	
	Pretest (if required)						
	Begin Line Test						

X. LINE TIGHTNESS TEST RESULTS

Allowable Bleedback (gallons):	NOTES Specify reason for fail or incomplete test results. Show all bleedback calculations.
Total Bleedback During Test (gallons):	
Net Volume Change Per Hour (gallons):	
PASS/FAIL	
Tester's Signature:	Test Date:

CN 1341 RDA 2304

XI. ACURITE LINE TIGHTNESS TEST FORM

- Test must be conducted for a minimum of one hour at 1.5 times maximum operating pressure, unless otherwise stated in the certification of the testing method.
- Pressure and volume readings must be taken at consistent time intervals for a minimum of 30 minutes, or until consistent product loss is achieved. Any volume loss greater than or equal to 0.01 gph will require additional diagnostic inspection and testing.
- Page 1 of this form must also be completed in order for test results to be valid.
- Pass or Fail criteria is stated in the third party certification.

Facility ID #:	Test Number
Facility Name:	Company Name:
Address:	Certification #/ Certification Expiration Date:
City, State:	Type of Cover (Asphalt, Concrete, etc.):
Ambient Air Temperature:	Approximate Burial Depth of Line (in.):

Line #					
Product Type:					
STP Manufacturer and Model					
STP Operating Pressure					
Test Location (Dispenser)					
Isolation Mechanism					
Test Pressure (psi)					
Initial Cylinder Level					
Final Cylinder Level					
Leak Volume					
Time Started					
Time Completed (30 Minute Minimum)					

XII. CONSTANT PRESSURE LINE TIGHTNESS TEST RESULTS

PASS/FAIL					

NOTES Specify reason for fail or incomplete test results.

Tester's Signature:	Test Date:

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XIII. ESTABROOK EZY-CHEK LINE TIGHTNESS TEST FORM

- Test must be conducted for a minimum of one hour at 1.5 times maximum operating pressure, unless otherwise stated in the certification of the testing method.
- Pressure and volume readings must be taken at consistent time intervals for a minimum of 30 minutes, or until consistent product loss is achieved. Any volume loss greater than or equal to 0.05 gph will require additional diagnostic inspection and testing.
- Page 1 of this form must also be completed in order for test results to be valid.

Facility ID #:	Name of Tester:	Company Name:
Facility Name:	Certification Number:	Address:
Facility Address:	Certification Expiration Date:	Phone #:

XIV. LINE TEST DATA AND RESULTS

Line #:			Product Type:		
Test Location:			Applied Pressure:		
STP Model			Operating Pressure (PSI):		
TIME	**DATA**	**+/-**	**GPL**	**RES**	**GPH**
		0			
FINAL RESULT (PASS/FAIL):					

Line #:			Product Type:		
Test Location:			Applied Pressure:		
STP Model			Operating Pressure (PSI):		
TIME	**DATA**	**+/-**	**GPL**	**RES**	**GPH**
		0			
FINAL RESULT (PASS/FAIL):					

Line #:			Product Type:		
Test Location:			Applied Pressure:		
STP Model			Operating Pressure (PSI):		
TIME	**DATA**	**+/-**	**GPL**	**RES**	**GPH**
		0			
FINAL RESULT (PASS/FAIL):					

Line #:			Product Type:		
Test Location:			Applied Pressure:		
STP Model			Operating Pressure (PSI):		
TIME	**DATA**	**+/-**	**GPL**	**RES**	**GPH**
		0			
FINAL RESULT (PASS/FAIL):					

NOTES Specify reason for fail or incomplete test results.

Tester's Signature:	Test Date:

XI. TANKNOLOGY TLD-1 LINE TIGHTNESS TEST FORM

- Test must be conducted for a minimum of 30 minutes at 150% operating pressure.
- Pressure and volume readings must be taken at consistent time intervals for a minimum of 30 minutes, or until consistent product loss is achieved. Any volume loss greater than or equal to 0.05 gph will require additional diagnostic inspection and testing.
- Page 1 of this form must also be completed in order for test results to be valid.
- Mechanical line leak detector must be removed or manually isolated from pipeline for duration of test, or check valve in pump must be manually closed if testing is to be conducted with mechanical line leak detector in place.

Facility ID #:	Work Order Number
Site Name:	Company Name:
Address:	Certification #/ Certification Expiration Date:
City, State:	Type of Cover (Asphalt, Concrete, etc.):
Ambient Air Temperature:	Approximate Burial Depth of Line (in.):

Line #	A	B	C	D	E
Product Type:					
Test Location:					
Piping Material:					
Diameter (in):					
Length (ft):					
Test psi:					
Bleedback cc:					
Test Time (min):					
Start Time:					
End Time:					
Final gph:					
Pump Type					
Pump Make					
Operating Pressure					

XII. TLD-1 LINE TIGHTNESS TEST RESULTS

PASS/FAIL					

NOTES Specify reason for fail or incomplete test results. List leaks observed even if repairs are made and retest passes

Tester's Signature:	Test Date:

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APPENDIX B
Procedure for Testing Automatic Line Leak Detectors
Mechanical Automatic Line Leak Detectors

<u>If required by the leak detector manufacturer, testing shall be conducted only by an authorized service technician.</u>

<u>Test Set-up</u>

1. Shut off power to the pump and perform lockout/tag out procedures on the circuit breakers.

2. Bleed line pressure to zero by activating the dispenser and opening the nozzle – allowing fuel to drain into an approved container. After all line pressure has been bled-off, hang up the nozzle and close the shear valve.

3. Connect the test apparatus to the shear valve test port at the highest dispenser. If there is no elevation change, connect the test apparatus at the furthest dispenser. Note: If the piping has master/satellite dispensers, the test apparatus must be connected to the furthest satellite dispenser.

4. Re-establish power to the pump. Open the shear valve and pressurize the line by activating the pump. Confirm that there are no leaks in the test apparatus or the connection to the shear valve test port.

5. Dispense product from the dispenser nozzle to remove all air from the line.

<u>Determine Operational Parameters of the Mechanical Line Leak Detector</u>

6. Close the dispenser nozzle and allow the line to fully pressurize. Record this as the full pump pressure.

7. Shut off the pump, close the shear valve and allow line pressure to decay until it stabilizes. Record this as the holding pressure. Note: If the line pressure does not stabilize, this may indicate that the check valve/functional element are defective or the packer o-ring in the pump head is leaking.

8. Bleed line pressure to zero by opening the test apparatus leak orifice and allowing fluid to drain into a graduated cylinder. The volume of fluid recovered is the resiliency and should be recorded in milliliters (ml).

9. After waiting for 2-5 minutes, fully close the test apparatus leak orifice, turn pump back on and observe pressure gauge. Pressure should rise quickly and pause for approximately 2-5 seconds before building to full pump pressure. Note: If the line pressure goes to full pump pressure without pausing, this indicates that the leak detector did not "trip" (move to the leak search position). If the leak detector did not move to the leak search position – repeat Step 8.

10. Observe the line pressure when it pauses and record this as the metering pressure.

11. Measure with a stopwatch the length of time it takes from pausing at the metering pressure until full pump pressure is achieved. Record this as the opening time. Note: If the opening time is greater than 2-5 seconds, this may indicate that there is air trapped in the line, the piping has high resiliency or a leak smaller than the leak detector is capable of detecting may exist in the piping. WARNING: You must pay

very close attention to the pressure gauge while measuring the opening time as this happens rather quickly.

Calibrate Test Apparatus Leak Orifice

Without the use of a pressure regulator:

12. Referencing the full pump pressure recorded in Step 6, determine from Table 1 the volume of fluid that must be discharged in 60 seconds at full pump pressure to simulate a leak equivalent to 3 gph @ 10 psi.

13. Turn the pump on and confirm that full pump pressure is indicated. Slowly open the test apparatus leak orifice and adjust until the flow rate determined in Step 12 has been achieved. Note: To do this, direct the fluid flow into a graduated cylinder while timing for 60 seconds. Continue to adjust the size of the test apparatus leak orifice until the desired flow rate is achieved. To expedite calibration, you may find it useful to initially make coarse adjustments by measuring the volume of fluid that corresponds to the 15 second time interval indicated in Table 1. However, the final calibration of the test apparatus leak orifice must be conducted by measuring the appropriate volume of fluid over the full 60 second time frame.

With the use of a pressure regulator:

12. Turn the pump on and confirm that full pump pressure is indicated. Slowly open the test apparatus leak orifice and direct the fuel flow into an approved container.

13. Adjust the line pressure to 10 psi with the pressure regulator. Direct the fluid flow into a graduated cylinder and time for 60 seconds. Adjust the size of the test apparatus leak orifice until the desired flow rate of 189 ml/min is achieved while maintaining a line pressure of 10 psi. Note: It may be necessary to readjust the pressure regulator and/or the test apparatus leak orifice several times in order to correctly set the leak rate at 189 ml/minute at a line pressure of 10 psi. To expedite calibration, you may find it useful to initially make coarse adjustments by measuring the volume of fluid that corresponds to 15 seconds (1/4 of 189 ml = 47 ml). However, the final calibration of the test apparatus leak orifice must be conducted by measuring 189 ml of fluid over the full 60 second time frame.

Determine if the Leak Detector Sees a Leak Equivalent to 3 gph @ 10 psi

14. Turn the pump off and allow the line pressure to bleed-off completely (0 psi) through the test apparatus leak orifice. This should cause the leak detector to "trip" (move into the leak sensing position). Note: Do not change the size of the test apparatus leak orifice after it has been properly calibrated in Step 13.

15. Turn the pump on and allow the simulated leak to occur through the calibrated test apparatus leak orifice. Note: If using a pressure regulator in the test apparatus, the pressure regulator must be completely bypassed or fully opened while conducting Steps 15 and 16.

16. Observe that the line pressure rises to the metering pressure (determined in step 10) and remains there indefinitely with the pump running and the simulated leak occurring through the calibrated test apparatus leak orifice. Note: The test must be conducted for a minimum of 60 seconds. If the line pressure rises to the full pump pressure at anytime during the test, this indicates that the leak detector has fully opened and fails the test.

17. Confirm that the leak detector is operating correctly by recording the line pressure observed in Step 16 as the leak test pressure. The leak test pressure should be equivalent to the metering pressure.

18. Measure the volume of fluid discharged from the test apparatus leak orifice while the leak detector is being tested in Step 16 by directing the flow into the graduated cylinder while timing for 60 seconds. Record this as the leak test volume. Note: The leak test volume should be equal to the volume of fluid that corresponds to the line pressure in Table 1.

19. Refer to Table 2 to determine the leak rate (expressed as gallons per hour) that corresponds to the leak volume observed in Step 18. Record this as the test leak rate.

Restore the System to Operational Condition

20. Cut the pump power off, allow line pressure to bleed-off to zero and close the shear valve. Perform lockout/tag out procedure on the circuit breakers.

21. Remove the test apparatus from the shear valve body and properly reinstall the plug into the shear valve test port.

22. Re-establish power to the pump and confirm that there are no leaks in the system.

23. Dispense product into an approved container to remove any air from the line and confirm that the leak detector is operating properly by observing that full product flow is achieved.

Pass/Fail Criteria

Pass - The line pressure does not increase above the metering pressure for the duration of the test with the simulated leak occurring.

Fail – The line pressure increases to full pump pressure while the simulated leak is occurring OR the leak detector does not reset (trip) when the line pressure is bled off to zero.

Note: If the leak detector initially fails the test, repeat the test procedure before declaring the test result as “fail”.

Electronic Automatic Line Leak Detectors

Determine Operational Parameters of the Electronic Line Leak Detector

1. From the control panel, verify that the system set-up parameters are correct (e.g. pipe diameter, pipe length, pipe material of construction, etc…).

2. If any of the set-up parameters are not correct, make any changes that may be necessary to bring the system settings to within specifications.

Test Set-up

3. Shut off power to pump and perform lockout/tag out procedures on the circuit breakers.

4. Bleed line pressure to zero by activating the dispenser and opening the nozzle – allowing fuel to drain into an approved container. After all line pressure has been bled-off, hang up the nozzle and close the shear valve.

5. Connect test apparatus to shear valve test port at the highest dispenser. If there is no elevation change, connect the test apparatus at the furthest dispenser. Note: If the piping has master/satellite dispensers, the test apparatus must be connected to the furthest satellite dispenser.

6. Re-establish power to the pump. Open the shear valve and pressurize the line by activating the pump. Confirm that there are no leaks in the test apparatus or the connection to the shear valve test port.

7. Dispense product from the dispenser nozzle to remove all air from the line.

8. Close the dispenser nozzle and allow the line to fully pressurize. Confirm that the line pressure observed is the full pump pressure.

Calibrate Test Apparatus Leak Orifice

Without the use of a pressure regulator:

9. Referencing the full pump pressure observed in Step 8, determine from Table 1 the volume of fluid that must be discharged in 60 seconds at full pump pressure to simulate a leak equivalent to 3 gph @ 10 psi.

10. With the pump running and the line at full pump pressure, slowly open the test apparatus leak orifice and adjust until the flow rate determined in Step 9 has been achieved. Note: To do this, direct the fluid flow into a graduated cylinder while timing for 60 seconds. Continue to adjust the size of the test apparatus leak orifice until the desired volume is achieved. To expedite calibration, you may find it useful to initially make coarse adjustments by measuring the volume of fluid that corresponds to the 15 second time interval indicated in Table 1. However, the final calibration of the test apparatus leak orifice must be conducted by measuring the appropriate volume of fluid over the full 60 second time frame.

With the use of a pressure regulator:

9. With the pump running and the line at full pump pressure, slowly open the leak test apparatus orifice and direct fluid into an approved container.

10. With the pressure regulator, adjust the line pressure to 10 psi. Direct the fluid flow into a graduated cylinder and time for 60 seconds. Adjust the size of the test apparatus leak orifice until the desired leak rate of 189 ml/min is achieved while maintaining a line pressure of 10 psi. Note: It may be necessary to readjust the pressure regulator and/or the test apparatus leak orifice several times in order to correctly set the leak rate at 189 ml/minute at a line pressure of 10 psi. To expedite calibration, you may find it useful to initially make coarse adjustments by measuring the volume of fluid that corresponds to 15 seconds (47 ml). However, the final calibration of the test apparatus leak orifice must be conducted by measuring a fluid volume of 189 ml over the full 60 second time frame.

Determine if the leak detector detects a leak equivalent to 3 gph @ 10 psi.

11. Without adjusting the test apparatus leak orifice after it has been properly calibrated in Step 9, hang-up the dispenser nozzle, allowing the pump to turn off.

12. While directing the fluid flow from the leak test apparatus into an approved container, observe that the electronic line leak detector turns the pump on and pressurizes the line.

13. Confirm that the simulated leak condition causes the electronic line leak detector to alarm and/or shut down the pump. Note: The electronic line leak detector may cycle the pump on/off several times before alarming or shutting down the pump. Record the number of test cycles observed before alarm/shutdown occurs.

Restore the System to Operational Condition

14. Cut the pump power off, allow line pressure to bleed-off to zero and close the shear valve. Perform lockout/tag out procedure on the circuit breakers.

15. Remove the test apparatus from the shear valve body and properly reinstall the plug into the shear valve test port.

16. Re-establish power to the pump and confirm that there are no leaks in the system.

17. Dispense product into an approved container to remove any air from the line and confirm that full product flow is achieved.

Pass/Fail Criteria

Pass - The electronic line leak detector alarms and/or shuts down the pump while the simulated leak is occurring.

Fail – The electronic line leak detector does not alarm or shut down the pump while the simulated leak is occurring. Note: If the leak detector initially fails the test, repeat the test procedure before declaring the test result as “fail”.

Table 1 - Volume that must be discharged within indicated time frame to be equivalent to a leak rate of 3 gph @ 10 psi:						
Line Pressure (psi)	15 seconds	60 seconds		Line Pressure (psi)	15 seconds	60 seconds
5	33 ml	134 ml		30	82 ml	328 ml
6	37 ml	147 ml		31	83 ml	333 ml
7	40 ml	158 ml		32	85 ml	338 ml
8	42 ml	169 ml		33	86 ml	344 ml
9	45 ml	179 ml		34	87 ml	349 ml
10	47 ml	189 ml		35	89 ml	354 ml
11	50 ml	198 ml		36	90 ml	359 ml
12	52 ml	207 ml		37	91 ml	364 ml
13	54 ml	216 ml		38	92 ml	369 ml
14	56 ml	224 ml		39	94 ml	374 ml
15	58 ml	232 ml		40	95 ml	378 ml
16	60 ml	239 ml		41	96 ml	383 ml
17	62 ml	247 ml		42	97 ml	388 ml
18	64 ml	254 ml		43	98 ml	392 ml
19	65 ml	261 ml		44	99 ml	397 ml
20	67 ml	268 ml		45	100 ml	401 ml
21	69 ml	274 ml		46	102 ml	406 ml
22	70 ml	281 ml		47	103 ml	410 ml
23	72 ml	287 ml		48	104 ml	415 ml
24	73 ml	293 ml		49	105 ml	419 ml
25	75 ml	299 ml		50	106 ml	423 ml
26	76 ml	305 ml		51	107 ml	427 ml
27	78 ml	311 ml		52	108 ml	431 ml
28	79 ml	317 ml		53	109 ml	436 ml
29	81 ml	322 ml		54	110 ml	440 ml
Adjust size of test apparatus leak orifice until the indicated flow rate is achieved.						

Table 2 – Conversion of leak rate from milliliters per minute (ml/min) to gallons per hour (gph)							
Leak Rate (ml/min)	Leak Rate (gph)		Leak Rate (ml/min)	Leak Rate (gph)		Leak Rate (ml/min)	Leak Rate (gph)
134	2.1		281	4.5		374	5.9
147	2.3		287	4.6		378	6.0
158	2.5		293	4.7		383	6.1
169	2.7		299	4.7		388	6.2
179	2.8		305	4.8		392	6.2
189	3.0		311	4.9		397	6.3
198	3.1		317	5.0		401	6.4
207	3.3		322	5.1		406	6.4
216	3.4		328	5.2		410	6.5
224	3.5		333	5.3		415	6.6
232	3.7		338	5.4		419	6.6
239	3.8		344	5.5		423	6.7
247	3.9		349	5.5		427	6.8
254	4.0		354	5.6		431	6.8
261	4.1		359	5.7		436	6.9
268	4.2		364	5.8		440	7.0
274	4.3		369	5.9		445	7.1
Note: 1 gallon per hour=63.06 milliliters per minute							

APPENDIX C

Example of Veeder Root TLS-350 PLLD/ WPLLD Pressure Line Leak Setup Report

PRESSURE LINE LEAK SETUP - Q 1: REGULAR TYP: APT P175SC LINE LENGTH: 200 FEET THERMAL COEFF: 0.000700 0.20 GPH TEST: REPETITIVE 0.10 GPH TEST: AUTO PASSIVE 0.10 GPH NO SHUTDOWN RATE: 3.0 GPH LOW PRESSURE SHUTOFF: NO LOW PRESSURE: 0 PSI T1: DISPENSE MODE: STANDARD SENSOR: NON-VENTED PRESSURE OFFSET: 0.0 PSI	Line Number- Location, Fuel Type, etc. Product Piping Type- determines piping resiliency, ELLD test results invalid if information is incorrect. Inspectors should verify piping type is correct. Line Length- adjustable setting for total length of piping from tank(s) to dispenser(s). Must be accurate to within 30% of actual line length or tests are invalid. For flexible piping lengths greater than 200 feet, the tank owner should demonstrate the maximum allowable line capacity for which the device is evaluated is not exceeded. Thermal Coefficient- specific to product type; determines allowable amount of liquid expansion due to temperature change. 0.0007 is standard for gasoline. 0.20 GPH Line Leak Test Scheduling- can be set to Disabled (default), Repetitive (starts after every 3.0 GPH test), Monthly, or Manual. 0.10 GPH Line Leak Test Scheduling- can be set to Disabled, Repetitive, Auto, or Manual. Passive 0.1 GPH- generates the most current passing 0.1 GPH test result. Shutdown Rate- programs ELLD to shut down product line after a failed leak test. Can be set to 3.0 GPH, 0.2 GPH, 0.1 GPH, or NONE. 3.0 GPH must be enabled at unmanned facilities or facilities will do not trigger an audible/ visual alarm. Low Pressure Alarm Shutoff- detects low pressure while dispensing and deactivates sub pump. Default value is 0. Adjustable from 0 to 25 psi. Tank Selection- indicates which pump (tank) the ELLD is controlling. Dispense Mode- selects type of dispense mode. Can be set to one of the following: • Standard- one submersible pump in piping system. • Manifolded Alternate- pump runs in tank with highest inventory volume. Product volume in tanks is determined by ATG. Each tank must have an LLD with this configuration for proper leak detection. • Manifolded Sequential- tanks are pumped to lowest volume possible one at a time. Product volume in tanks is determined by ATG. Each tank must have an LLD with this configuration for proper leak detection. • Manifolded: All Pumps- all STP's in the line are run at the same time. Proper leak detection is not possible with this setting since one or more STP's operating concurrently cannot be monitored. Sensor- indicates ELLD pressure transducer type. Pressure Offset- Adjustable setting in later PLLD software versions, used to compensate for atmospheric pressure changes at higher altitudes. Should be set to 0.0 PSI in altitudes below 2,000 feet.
Note: Programming options may vary depending on Veeder-Root PLLD software revisions.	

Example of Veeder Root TLS-350 Pressure Line Leak Test History Report

FACILITY NAME ADDRESS TOWN, STATE, ZIP PHONE NUMBER	This is an example of a report generated at a facility using Veeder Root PLLD/WPLLD electronic line leak detectors. Facility Name, Address, and Contact Information- verify reports originated from the facility being inspected. Verify facility information is correct.
JANUARY 1, 2011, 12:12 AM	Current Date and Time- indicates when report was generated.
PRESSURE LINE LEAK TEST HISTORY	Name of Report- Pressure Line Leak History
Q 1: REGULAR	Line Number- Location, Fuel Type, etc.
LAST 3.0 GAL/ HR PASS: JANUARY 1, 2011, 12:00 AM	Last 3.0 GAL/HR PASS- indicates date and time of the most recent 3.0 gph catastrophic leak test was completed by the ELLD. This test should be completed each time the submersible pump is activated for fuel dispensing. If date of test is not recent, check alarm history reports for 3.0 GPH leak alarms.
FIRST 0.20 GAL/ HR PASS EACH MONTH: JAN 1, 2010 1:30 PM FEB 2, 2010 1:12 AM MAR 3, 2010 2:34 AM APR 4, 2010 3:56 AM MAY 5, 2010 3:33 AM JUN 6, 2010 1:15 AM JUL 7, 2010 12:02 AM AUG 8, 2010 1:10 AM SEP 9, 2010 2:15 AM OCT 10, 2010 1:45 AM NOV 11, 2010 4:30 AM DEC 1, 2010 10:15 AM	First 0.20 GAL/HR PASS EACH MONTH- if a facility is using monthly 0.2 gph leak detection as the primary method for piping, a passing test result should be available for each of the previous 12 months.
FIRST 0.10 GAL/ HR PASS EACH MONTH: OCT 2, 2010 1:12 AM FEB 2, 2010 2:34 AM MAR 2, 2010 3:56 AM	First 0.10 GAL/HR PASS EACH MONTH- if a facility is using 0.1 gph annual line leak detection for piping, one (1) passing 0.1 gph test should be generated for each line at the facility within the past twelve (12) months.
Note: Programming options may vary depending on Veeder-Root PLLD software revisions.	

Example of INCON TS-2001 System Setup Report Using LS-300 Electronic Leak Detector

FACILITY NAME ADDRESS TOWN, STATE, ZIP PHONE NUMBER JANUARY 1, 2011 9:50 AM SYSTEM SETUP REPORT SYSTEM INFO SOFTWARE PART VER 1.07 RELEASED --- LINES NUMBER OF LINES 2 LINE 1 NAME REGULAR TEST FAIL O/G NONE TEST FAULT O/G NONE LINE 2 NAME PREMIUM TEST FAIL O/G NONE TEST FAULT O/G NONE --- LINE TESTS 0.1 GPH TEST SCHEDULES LINE 1 SCHEDULE NONE TIME 12:00 AM LINE 2 SCHEDULE NONE TIME 12:00 AM	INCON electronic leak detector systems utilize an "Autolearn" software algorithm to set product and piping volume parameters during system startup. Factors such as piping type, piping length, and product thermal coefficients are not programmable and do not need to be verified. Inspectors should only need to review this report if there are discrepancies in tank/line configurations or questions regarding alarm outputs. Facility Name, Address, and Contact Information- verify reports originated from the facility being inspected. Verify facility information is correct. Current Date and Time- indicates when report was generated. Name of Report- System Setup Report System Information- lists ATG model, software version, and date of software installation. Number of Lines- indicates total number of piping systems monitored by electronic leak detectors at the facility. Line Number- indicates specific tank/piping system to which the records are associated. The line number should also match the tank to which the piping is connected in the ATG setup report. Line Name- usually fuel grade such as regular, diesel, etc. Test Fail O/G (output group)- an alarm type to which a failing leak test is assigned. ATG technicians can program an automatic tank gauging (ATG) system to report all or none of any type of alarm assigned to a specific output group. Any alarm within this output group will trigger a programmable audible and/or visual alarm. **Passing or failing leak tests will not be printed or recorded in the alarm history if an output group is not assigned.** Test Fault O/G- (output group)- The output group to which the device (ELLD) is assigned. All ELLD's assigned to this group will trigger the same type of programmable alarm. **Passing or failing leak tests will not be printed or recorded in the alarm history if an output group is not assigned.** Line Test Schedules- category for assigning test routine and/or times for testing. Schedule- includes separate categories for 3.0 gph, 0.2 gph, and 0.1 gph testing. 3.0 gph tests are conducted prior to each fuel dispense. 0.2 and 0.1 gph tests can set programmed to run daily, weekly, or monthly. Time- time of day which ATG system is programmed to conduct 0.2 gph and/or 0.1 gph line leak tests on the specifically assigned day.

Note: Only applicable sections are shown, setup reports also contain tank information. Programming options may vary depending on INCON software revisions.

Example of INCON TS-2001 Monthly Line Test Report

FACILITY NAME
ADDRESS
TOWN, STATE, ZIP
PHONE NUMBER

JANUARY 1, 2011 9:50 AM

LINE TEST REPORT

LINE NO. 1	REGULAR
3 GPH TESTS PASSED	25
START TIME	11:00 AM
START DATE	12/15/10
END TIME	11:21 AM
END DATE	12/15/10
LINE TEST	0.20 GPH
LEAK RATE	0.00 GPH
TEST RESULT	PASSED
LINE NO. 2	MID GRADE
3 GPH TESTS PASSED	8
START TIME	11:00 AM
START DATE	12/15/10
END TIME	11:45 AM
END DATE	12/15/10
LINE TEST	0.20 GPH
LEAK RATE	**0.31 GPH**
TEST RESULT	**FAILED**

The INCON Line Test Report will automatically print when a 0.2 or 0.1 gph line leak test completes if the report is enabled in the System Setup. This report shows the latest line leak tests of a selected line or for all lines. The 3 gph tests print first and are followed by the most recent 0.1 or 0.2 gph line leak test results of the present day.

Facility Name, Address, and Contact Information- verify reports originated from the facility being inspected. Verify facility information is correct.

Current Date and Time- indicates when report was generated.

Name of Report- Line Test Report

Line Number- indicates specific tank/piping system to which the records are associated. The line number should also match the tank to which the piping is connected in the ATG setup report.

3 GPH tests passed- indicates number of 3 GPH tests passed within the past 24 hours.

Start Time- indicates time 0.2 or 0.1 gph test was started.

Start Date- indicates date 0.2 or 0.1 gph test was started.

End Time- indicated time 0.2 or 0.1 gph test was completed.

End Date- indicates date 0.2 or 0.1 gph test was completed.

Line Test- leak rate used for test. Test will fail if leak rate exceeds allowable leak threshold (half of leak rate).

Leak Rate- actual calculated leak rate calculated during test. Leak threshold for test is half of allowable leak rate (0.1 gph threshold for 0.2 gph leak test).

Test Result- PASSED or FAILED. No test result will be generated if line leak test is aborted or cancelled.

Note: Programming options may vary depending on INCON software revisions.

Example of INCON TS-2001 Line Leak Test History Report

FACILITY NAME ADDRESS TOWN, STATE, ZIP PHONE NUMBER JANUARY 1, 2011 9:50 AM LINE TEST HISTORY LINE NO. 1 REGULAR START TIME 2:00 AM START DATE 12/12/2010 END TIME 2:20 AM END DATE 08/15/2010 LINE TEST 0.20 GPH LEAK RATE 0.02 GPH TEST RESULT PASSED START TIME 2:00 AM START DATE 11/30/2010 END TIME 2:20 AM END DATE 08/15/2010 LINE TEST 0.20 GPH LEAK RATE 0.04 GPH TEST RESULT PASSED START TIME 4:45 AM START DATE 10/15/2010 END TIME 2:20 AM END DATE 08/15/2010 LINE TEST 0.20 GPH LEAK RATE **0.31 GPH** TEST RESULT **FAILED**	This is an example of a Line Test History Report generated by an INCON TS-2001 tank monitor and a INCON LS-300 electronic leak detector. This report shows the last 10 pass or failed line leak tests per line (the first page of a multi-page report is shown). Facility Name, Address, and Contact Information- verify reports originated from the facility being inspected. Verify facility information is correct. Current Date and Time- indicates when report was generated. Name of Report- Line Test History Line Number- indicates specific tank/piping system to which the records are associated. The line number should also match the tank to which the piping is connected in the ATG setup report. Start Time- indicates time 0.2 or 0.1 gph test was started. Start Date- indicates date 0.2 or 0.1 gph test was started. End Time- indicated time 0.2 or 0.1 gph test was completed. End Date- indicates date 0.2 or 0.1 gph test was completed. Line Test- leak rate used for test. Test will fail if leak rate exceeds allowable leak threshold (half of leak rate). Leak Rate- actual calculated leak rate calculated during test. Leak threshold for test is half of allowable leak rate (0.1 gph threshold for 0.2 gph leak test). Test Result- PASSED or FAILED. No test result will be generated if line leak test is aborted or cancelled.
Note: Programming options may vary depending on INCON software revisions.	

Example of INCON TS-2001 Line Compliance Report

<table>
<tr>
<td>
FACILITY NAME
ADDRESS
TOWN, STATE, ZIP
PHONE NUMBER

JANUARY 1, 2011 9:50 AM

LINE COMPLIANCE REPORT

LINE NO. 1 REGULAR

PASSED MONTLY TESTS

TEST TIME 1:42 AM
TEST DATE 12/15/2010
LINE TEST 0.20 GPH
LEAK RATE 0.01 GPH

TEST TIME 11:12 PM
TEST DATE 11/30/2010
LINE TEST 0.20 GPH
LEAK RATE 0.00 GPH

TEST TIME 2:26 AM
TEST DATE 10/30/2010
LINE TEST 0.20 GPH
LEAK RATE 0.03 GPH

LINE NO. 2 PREMIUM

TEST TIME 1:55 AM
TEST DATE 12/15/2010
LINE TEST 0.20 GPH
LEAK RATE 0.00 GPH

TEST TIME 2:20 AM
TEST DATE 11/16/2010
LINE TEST 0.20 GPH
LEAK RATE 0.00 GPH

TEST TIME 12:15AM
TEST DATE 10/10/2010
LINE TEST 0.20 GPH
LEAK RATE 0.00 GPH
</td>
<td>
This is an example of a Line Compliance Report generated by an INCON TS-2001 tank monitor and a INCON LS-300 electronic leak detector. Only the most recent passing test result during each of the previous 12 months for each tank is shown. Failed line leak tests are not shown.

<u>Facility Name, Address, and Contact Information</u>- verify reports originated from the facility being inspected. Verify facility information is correct.

<u>Current Date and Time</u>- indicates when report was generated.

<u>Name of Report</u>- Line Test History

<u>Line Number</u>- indicates specific tank/piping system to which the records are associated. The line number should also match the tank to which the piping is connected in the ATG setup report.

<u>Test Time</u>- indicates time 0.2 or 0.1 gph test was completed.

<u>Test Date</u>- indicates date 0.2 or 0.1 gph test was completed.

<u>Line Test</u>- leak rate used for test. Test will fail if leak rate exceeds allowable leak threshold (half of leak rate).

<u>Leak Rate</u>- actual calculated leak rate calculated during test. Leak threshold for test is half of allowable leak rate (0.1 gph threshold for 0.2 gph leak test).
</td>
</tr>
</table>

Example of OPW EECO (1500, 2000, Galaxy) ATG Line Leak Test Report

(Report Header) **10-14-00 09:15:00** **STATIC LEAK TEST REPORT** **TANK 1 REGULAR** **TEST TYPE: CONTINUOUS, 0.2 GPH** **THRESHOLD: 0.1** **LAST DELIVERY: 10-13-00 01:37** **TEST START DATE: 10-13-00** **TEST START TIME: 22:44** **TEST LENGTH: 4.03 HOUR(S)** **TANK CAPACITY: 12031 US GAL** **% FULL VOLUME: 60** **PRODUCT LEVEL: 56.54”** **GROSS VOLUME: 7373.54 US GAL** **NET VOLUME: 7327.31 US GAL** **PRODUCT TEMP: 70.22 F** **RTD 1: 70.3 F** **RTD 2: 70.2 F** **RTD 3: 70.2 F** **RTD 4: 71.6 F** **RTD 5: 71.7 F** **WATER LEVEL: 1.33”** **WATER VOLUME: 34.14 US GAL** **COEFF 1: 0.0785** **TEST RESULT: PASSED** **LEAK RATE: 0.05 GPH** **VOLUME IS DECREASING** **10-14-00 09:15:00** **(Report Header)** **0.2 GPH LEAK TEST FINISHED** **PASSED FOR LINE 1** **	The OPW EECO LLD electronic line leak detector generates a passing leak test report that is generated at the same time as the tank leak test report is performed. The line leak test report is printed at the end of the tank test report as seen below.